

AIR WAR COLLEGE

AIR UNIVERSITY

**AMERICA'S STRATEGIC IMPERATIVE:
A NATIONAL ENERGY POLICY MANHATTAN PROJECT**

by

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Chapter 1

Introduction

The U.S. presence in the Middle East stretches back to the closing days of World War II when then-President Roosevelt first met King Saud aboard a U.S. warship in the Suez Canal. Through the ensuing thirty years, the U.S. sought to maintain Middle East oil access and contain the Soviet Union by seeking Persian Gulf allies. This mutually beneficial relationship was forever altered in the aftermath of the Yom Kippur War and the subsequent oil embargo. The 1973-1974 oil embargo and its far-reaching economic impact sharply focused the strategic importance of the Middle East and elevated oil access to the level of a U.S. core national interest.

Saddam Hussein's 1990 invasion of Kuwait ushered in a new chapter of U.S. history in the Middle East. Since the invasion of Kuwait, the U.S. has fought three Middle East and Central Asian wars to ensure U.S. energy security. As America's efforts in Iraq and Afghanistan enter their fourth year, the final outcome is anything but clear. Given the determination of a motivated and patient foe in the face of American arms, we must consider the long-term prospects of our military and diplomatic strategy and the likelihood that it will help the U.S. achieve its energy security objectives.

Imported oil dependence has become the proverbial elephant in the foreign policy living room; an over-riding strategic consideration in a multitude of issues. In the short-

term, U.S. strategic options are driven by the imperative to achieve a favorable outcome in Iraq, Afghanistan, and on other Global War on Terror battlefields; thus it is not the intent of this paper to address the immediate strategic situation.

Current U.S. energy strategy assumes that this country can meet its oil needs by managing the major oil producing countries diplomatically and militarily. However, this energy strategy over-estimates the available oil supply, ignores the growing social and political instability in the oil producing countries, and understates the military costs of preserving oil access.

U.S. energy strategy must adopt a more realistic view of the limited available oil and recognize the diplomatic and military costs of obtaining that oil. If U.S. energy strategy were to correctly estimate the remaining oil supply and recognize the nation's cost to access it, it would incent users to consume less and accelerate development of alternatives. The U.S. must embark on a comprehensive energy independence "Manhattan Project" to develop and deploy as many effective oil conservation and replacement measures as possible.

Chapter 2

The Current U.S. Energy Policy

In May 2001, the National Energy Policy Development Group published the Bush Administration's energy policy. The *National Energy Policy* states: "Extraordinary advances in technology have transformed energy exploration and production. Yet we produce 39 percent less oil today than we did in 1970, leaving us ever more reliant on foreign suppliers. On our present course, America 20 years from now will import nearly two of every three barrels of oil—a condition of increased dependency on foreign powers that do not always have America's interests at heart.¹

The *National Energy Policy* addresses this growing dependence on foreign sources of oil by "promoting enhanced oil and gas recovery from existing [domestic] wells through new technology."² The *National Energy Policy* also directs the Secretary of the Interior to "examine land status and lease stipulation impediments to federal oil and gas leasing, and review and modify those where opportunities exist."³ These policies aim to increase domestic production by enhanced efficiency in existing oil fields and by exploiting heretofore environmentally denied areas such as the Alaska National Wildlife Refuge (ANWR). Although increasing the domestic fraction of our total oil consumption is a worthy goal, achieving a meaningful effect promises to be very difficult given that domestic production is currently declining at an annual rate of 1.5 million barrels per day.⁴

The *National Energy Policy* also advocates improved conservation. “A recent analysis indicates that the fuel economy of a typical automobile could be enhanced by 60 percent by increasing engine and transmission efficiency and reducing vehicle mass by about 15 percent. Advanced lightweight materials offer up to 6 percent improvement in mileage for each 10 percent reduction in body weight.”⁵ The primary means of increasing automotive economy is through mandated Corporate Average Fuel Economy (CAFE) standards. “Responsibly crafted CAFE standards should increase efficiency without negatively impacting the U.S. automotive industry. The determination of future fuel economy standards must therefore be addressed analytically and based on sound science.”⁶ The CAFE standard has remained fixed since 1985. Although the *National Energy Policy* sounds a clear call for updated CAFE standards, no legislation has come forward since the *National Energy Policy* was published.

Finally, despite ample reference to alternative energy sources, this has not translated into budgetary reality. The 2004 Department of Energy budget for all types of renewable energy totaled \$1.3B, increasing just 0.1% from 2002 to 2004, while lagging the entire Department of Energy budget which increased 5.9%.⁷ This trend continues in the Administration’s preliminary 2005 budget submission.

Taken in whole, the *National Energy Policy* does not offer a compelling solution to the growing danger of foreign oil dependence. Even if ANWR were fully exploited, the proven reserves total about 7.7 billion barrels of recoverable oil, enough to supply the U.S. for just over one year.⁸ The envisioned increases in the domestic oil supply will be very difficult to realize, and environmental groups will resist these drilling policies as a continuation of the status quo. Although the *National Energy Policy* identifies potential conservation and alternative technologies, no meaningful fiscal policy steps have been taken to bring them to the fore.

Lastly, despite acknowledging that remaining world oil supplies total approximately 990 billion barrels of oil, this information is not carried to the next logical step.⁹ Assuming 3% growth in annual demand, the world's remaining oil supply will be exhausted in 22 years.¹⁰ The oil depletion situation may actually be even worse since this scenario assumes that oil will flow freely right up until the last barrel is extracted from the ground. Chapter 3 offers a more likely oil scarcity scenario as world oil supplies reach peak production and then begin to decline.

Chapter 3

Dwindling Global Oil Supply

Petroleum Economics

A growing body of experts warn that world oil production will soon peak. New oil discoveries lag far behind the rate of consumption. Lack of additional discovery and anticipated production declines pose dire consequences for the U.S. economy. The current U.S. energy policy is heavily weighted towards drilling rather than conservation, and does not adequately address the energy security risk of shrinking oil supplies.

A historical review of the answer to the question of “how much oil remains” reveals that the answer has continually changed throughout the past 146 years of petroeconomic history. Like many other measures of wealth and future power, governments and oil companies have many incentives to exaggerate or conceal oil reserves, and few motives for transparency.

In 1956, geophysicist M. King Hubbert developed a mathematical model for petroleum extraction. Hubbert’s Curve predicts that early in the life of an oil field, production will increase rapidly, as growing infrastructure allows production to rise--the “easy” to discover and “easy” to extract oil will be produced first. At some point, Hubbert theorized that an oil field would reach a point where production peaks, and barring new discoveries, no addition of technology would yield gains in production--this point, known as “Hubbert’s Peak” marks the onset of declining production, a trend that accelerates as the cost of further extraction approaches the commercial

value of each barrel pumped from the ground. An example of the Hubbert Curve appears below in Figure 1.

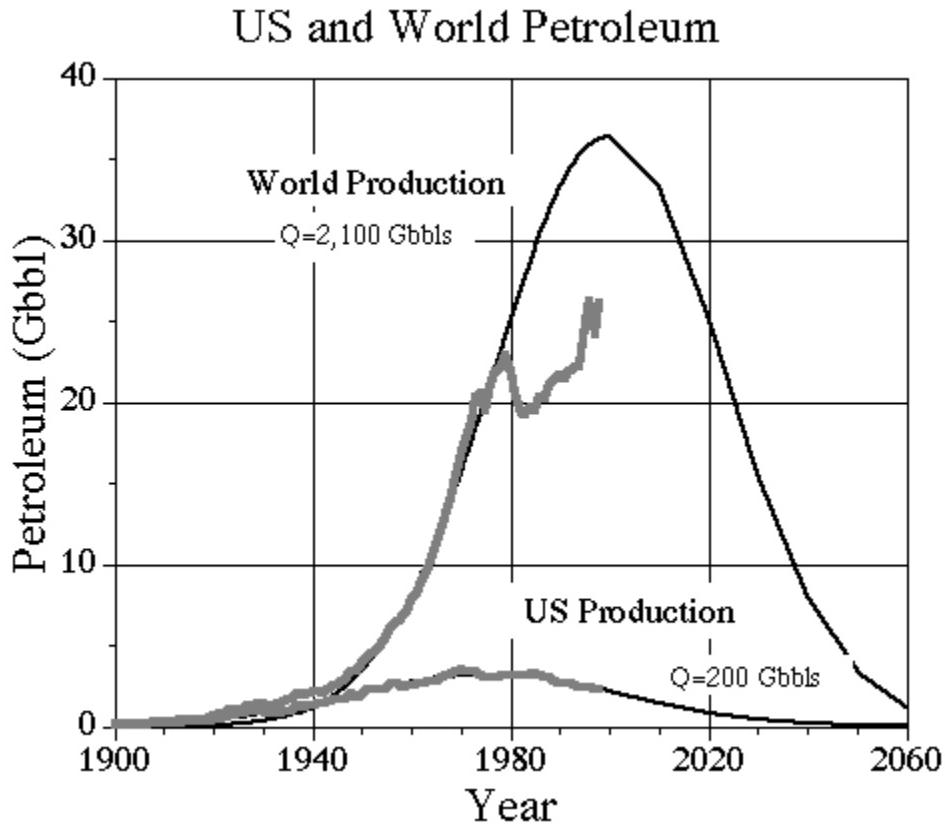


Figure 1: The Hubbert Curve¹¹

The Hubbert Curve illustrates a key reality of oil production. In many “easy” oil instances, the oil is actually pressurized coming out of the ground, reminiscent of the “gusher” seen in Hollywood movies. In an oil field with this so-called “high lift”, the price of the oil *at the wellhead* is less than \$5.00; post-wellhead costs are added through royalties, transportation, refining, delivery, and corporate profit.¹² As more oil is extracted, the pressurizing “lift” gradually weakens to “ooze” followed inevitably by the need to pump the oil out of the ground, thus price at the wellhead rises through the life of an oil field. Eventually, the cost of extracting the next barrel of oil exceeds the oil’s market value and the well is capped awaiting a rise in the price of oil or perhaps abandoned altogether.

Hubbert based his work on oil production within the lower-48 region of the U.S., the region where oil was first commercially exploited on a large scale, and due to its burgeoning economy, an area rich in economic incentives to discover and pump every available barrel of oil. Hubbert predicted that within a given oil field, the peak in new *discoveries* would be followed within a few years by a peak in *production*, and then inevitable decline. Hubbert also postulated that peak *production* would occur when approximately half of the total reserves in a given area had been depleted. In 1956, Hubbert forecast that U.S. lower-48 oil production would reach its maximum in approximately 1970, a prediction ultimately validated.

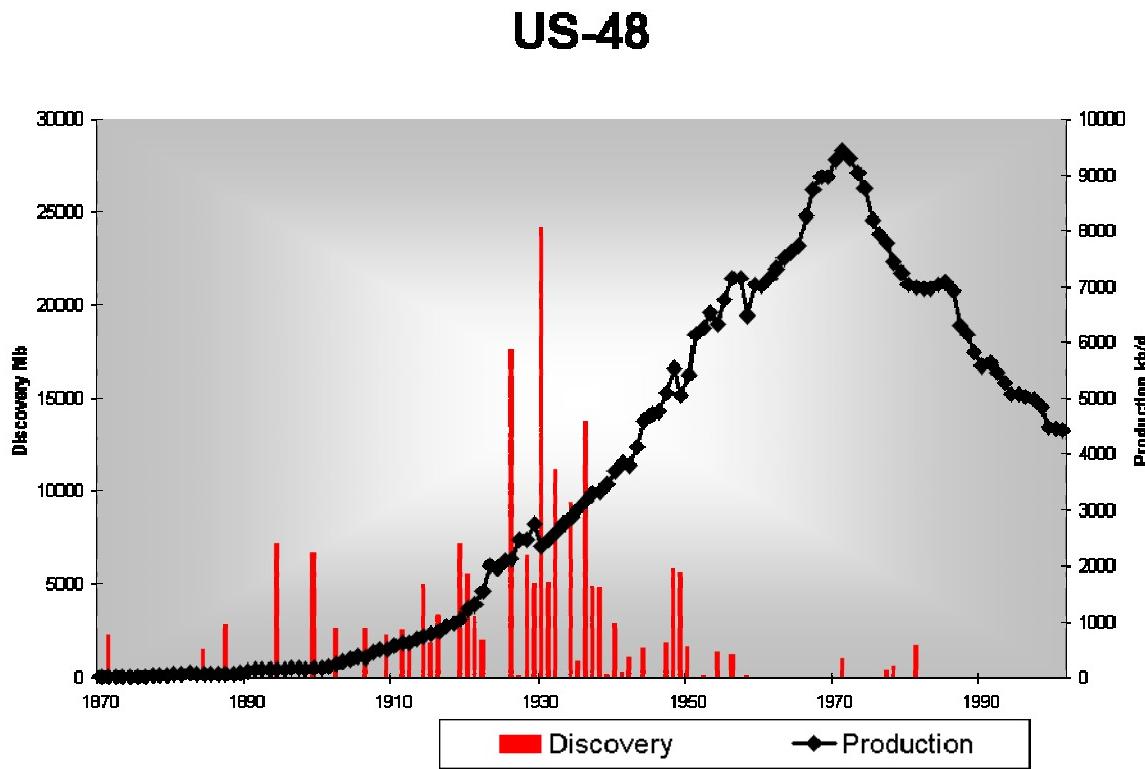


Figure 2: U.S. Lower-48 Crude Oil Discovery versus Production¹³

The United Kingdom's portion of the North Sea reveals a similar pattern of peak and decline. The North Sea oil fields reached their Hubbert Peak in 1999 and are now in decline, with production expected to cease sometime after 2020.

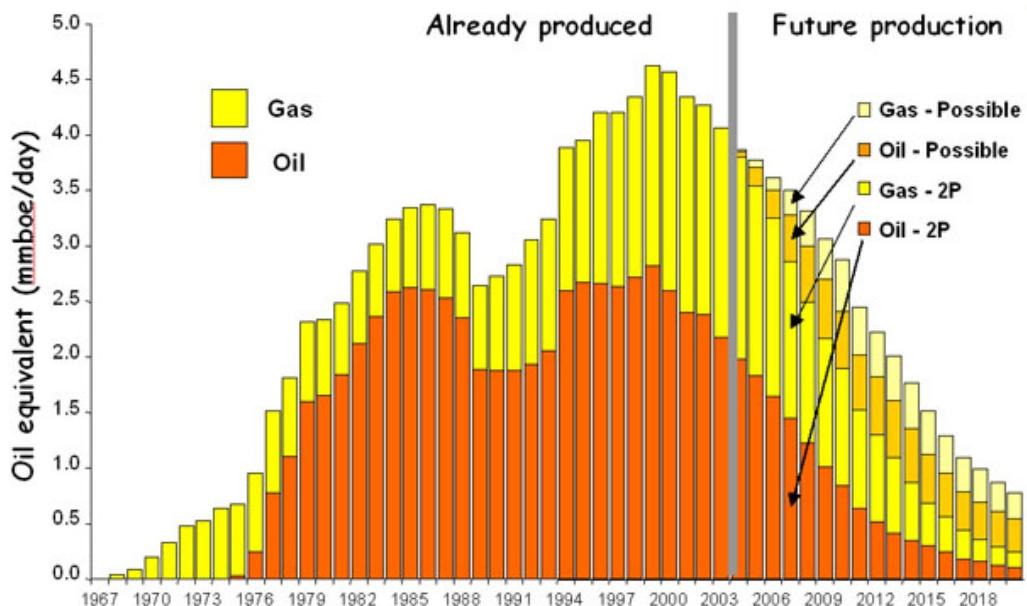


Figure 3: United Kingdom North Sea Oil Production¹⁴

How Much Oil Remains in the World?

Forecasting the peak of global oil production is far more difficult than predicting the peak for one oil field. Although nations such as the United Kingdom are forthright with their production statistics, many oil producing nations are very secretive. In this atmosphere of secrecy, global forecasting tools rely on reconciling divergent views to arrive at an overall consensus. Prior to 2000, the majority of studies projected an ultimate recoverable supply of approximately 2 trillion barrels of oil. In 2000, the U.S. Geological Survey (USGS) published a study forecasting a nearly 50% increase in estimated world reserves to 3.003 trillion barrels. As soon as it was published, the USGS study came under fire for what many considered optimistic

assumptions. Discounting the USGS results, there has historically been broad agreement that the world's ultimate oil supply equaled approximately 2 trillion barrels, from which only a few eccentric high estimates depart. As shown in Figure 4, the average estimate of 76 studies works out at 1930 billion barrels, of which 920 billion barrels, or almost half (48%), have already been consumed.

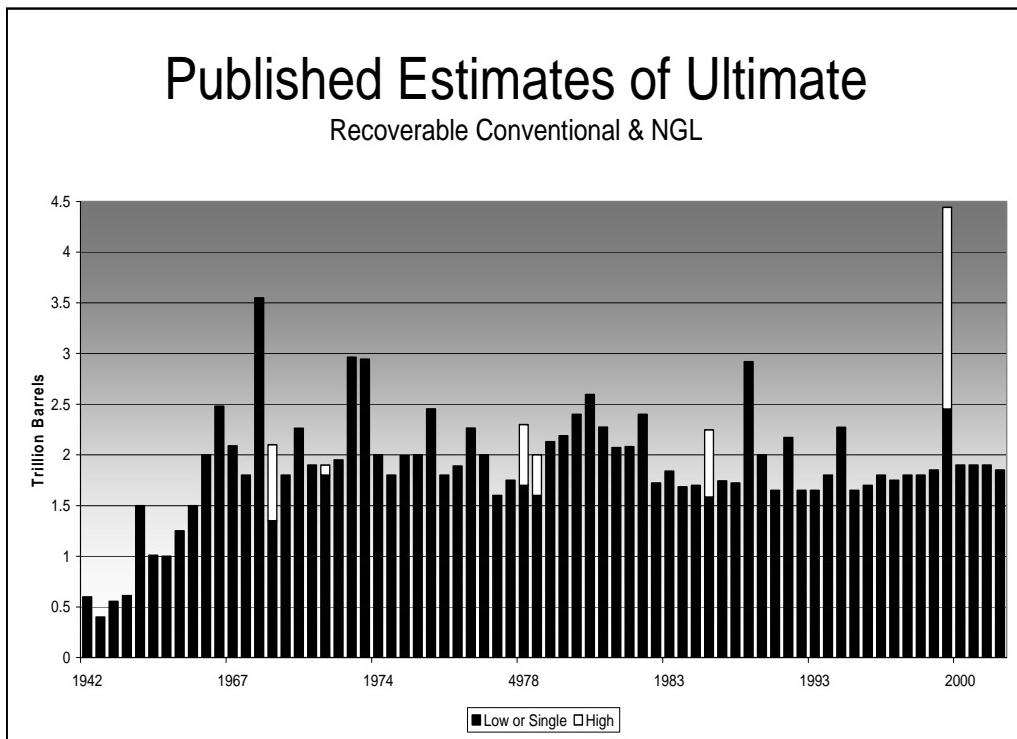


Figure 4: Total World Oil Supply Estimates by Credible Sources¹⁵

Today, the oil supply prediction camp is divided among the “optimists” represented by organizations such as the USGS, and “pessimists” such as the Association for the Study of Peak Oil and Gas. The optimists agree that Hubbert’s Peak is coming; however their view is that it will not occur until 2021 at the earliest and 2112 at the latest, with 2037 as the median date.¹⁶ The pessimists believe that the USGS study was based on speculative methodology, and in their view, the Hubbert Peak is much closer, perhaps as early as 2007. The pessimists cite the

growing gap between discovery and production as the basis for their assertion that world oil production will soon peak. The Pessimists say that if the USGS predictions are accurate, the annual discovery rate between 1995 and 2025 needs to average 21.6 billion new barrels of oil per year. Excluding USA and Canada, whose new discoveries have been negligible, new global oil discoveries over the last twelve years have averaged 7.4 billion barrels per year, far below USGS predictions and far below global consumption, which averaged 28 billion barrels per year for the same period.

New Global Discoveries in Billions of Barrels, 1992-2004					
1992	7.80	1996	5.42	2000	12.60
1993	4.00	1997	5.92	2001	8.90
1994	6.95	1998	7.60	2002	9.00
1995	5.62	1999	13.00	2003	2.27
					2004 <i>estimated</i>

Table 1: Annual Trends in New Oil Discovery (Excluding USA and Canada)¹⁷

Figure 5 overlays past global oil discoveries with total production. Since 1980, more oil has been extracted from the ground than has been offset by new discoveries.

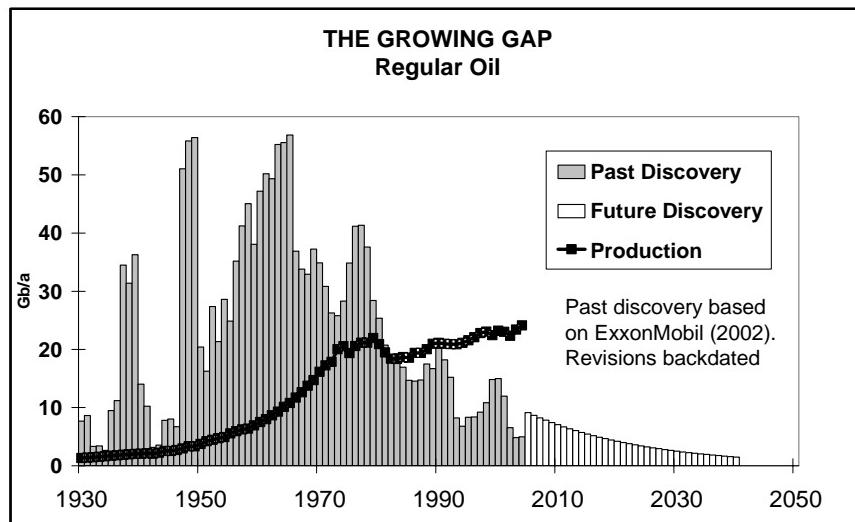


Figure 5: Historic and Forecast Oil Discovery and Production Trends¹⁸

Hubbert's Peak

Precisely forecasting the peak in worldwide oil production depends on a variety of factors. Although there is a geologic maximum supply of oil, access to these supplies is impacted by real-world considerations such as war, weather, natural disaster, political policy, and infrastructure investment decisions. Most of the “easy” oil has already been discovered or extracted, leaving the bulk of the undiscovered or unexploited oil in deep water, or other isolated locales far from transportation infrastructure and markets. The most promising sources of future oil discoveries are in the Caspian Basin and Russia, areas torn by strife and instability. A predictive depiction of future oil production patterns (produced by the pessimists) appears below in Figure 6, forecasting a peak in global oil production in approximately 2007.

“a). All regions except Africa have already passed through their peaks: North America (1985), Europe and Eurasia (1987), the Middle East (2000), Asia Pacific (2000), and South and Central America (2002). b). Of the 48 largest oil-producing countries, which account for at least 98 percent of world oil extraction, only 17 were past their peaks as of 1993, but 31 were past peak as of 2002. c). Decline has set in among many major producers. In each year 1993-1997, at least 30 major producing countries showed output increases. Output declined in 29 major countries in 2001, in 27 in 2002, and in 22 in 2003.”¹⁹

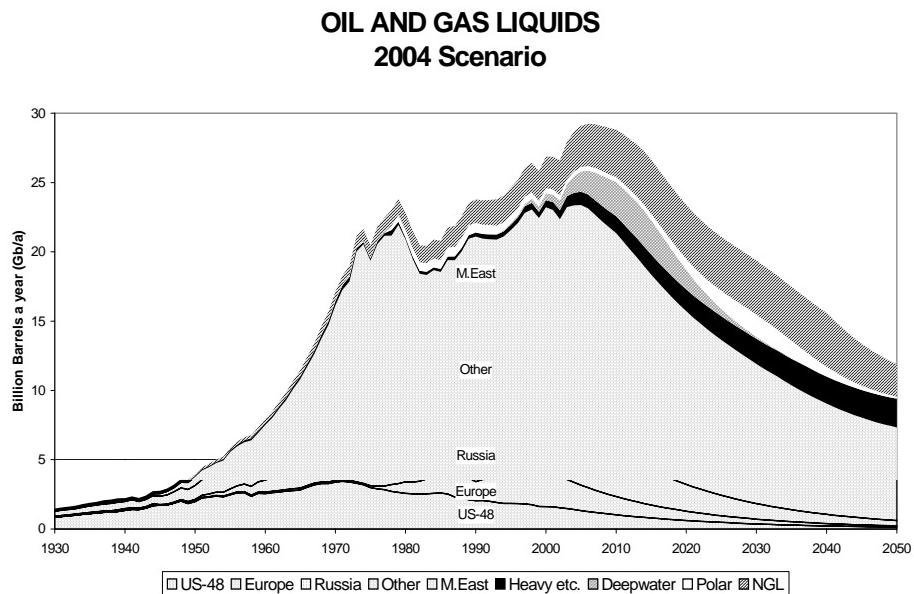


Figure 6: Predicted Future World Oil Production²⁰

Since the USGS report of 2000, most responsible studies have distanced themselves from the USGS numbers. A summer 2004 report by BP-AMOCO estimated the *remaining* oil supply at 1147.8 billion barrels²¹, a figure in close agreement with the current supply estimate from the U.S. Energy Information Agency, which estimates remaining supplies at 1266 billion barrels.²² These studies buttress the view that we are approaching world-wide peak oil production.

Unlike many other commodities, the relationship between the price of a barrel of oil and production is not linear. Classic economics suggest that as demand rises, the price of a barrel of oil would also rise, thus encouraging new supply or imposing cost-driven austerity. Although this is partially true, oil prices are also subject to political instability, weather patterns, market sentiment, and the cartel policies of OPEC. Figure 7 presents a historical record of the price of a barrel of oil since commercial use first began in the 1860s. As Figure 7 shows, the “money of the day” price of oil remained stable for the first hundred years of petrohistory, only rising during the oil crisis of 1973-1974. The oil crisis was mainly one of sentiment and short-term supply, plenty of oil was actually available from non-OPEC sources; however, delays in exploitation created a crisis in the minds of traders and consumers. Many of the circumstances unique to the 1973-1974 crisis, such as still-robust U.S. domestic reserves, have now disappeared. Although Figure 7 does not include data for 2005, recent prices have risen as high as \$55 per barrel, suggesting growing market pressure as available supply struggles to meet world demand. “This, surely, is a strong sign that economic forces alone do not govern how much oil is extracted, and that geological reality, i.e., resource finitude and depletion is starting to take over.”²³

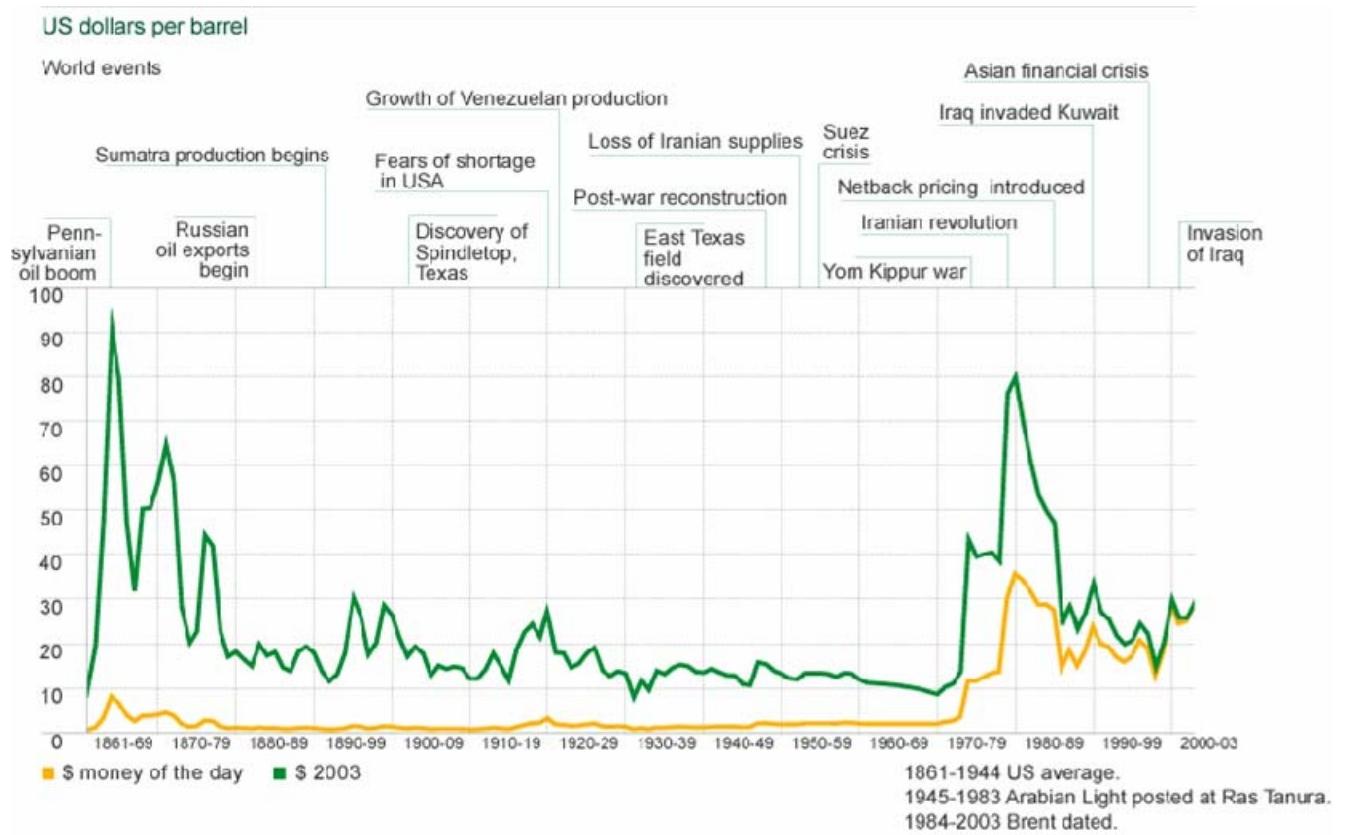


Figure 7: Spot Oil Prices Dollars per Barrel versus World Events²⁴

Chapter 4

America's Fragile Oil Lifeline

Although the pessimists present a convincing argument presaging a peak in global oil production, what if they are wrong? What if technology and discovery are able to delay this event far into the 21st Century? In that case, assuming the oil is available “somewhere” on the globe; can we reliably deliver it “here”? Figure 8 maps the foreign sources of U.S. oil. During 2003, “the United States averaged imports of 12.2 million barrels per day (MMBD), representing around 62% of total U.S. oil demand. The top suppliers of oil to the U.S. during 2003 were Canada (2.1 MMBD), Saudi Arabia (1.8 MMBD), Mexico (1.6 MMBD), and Venezuela (1.4 MMBD). So far in 2004, the next tier of producers include Nigeria, Iraq, and Angola.²⁵

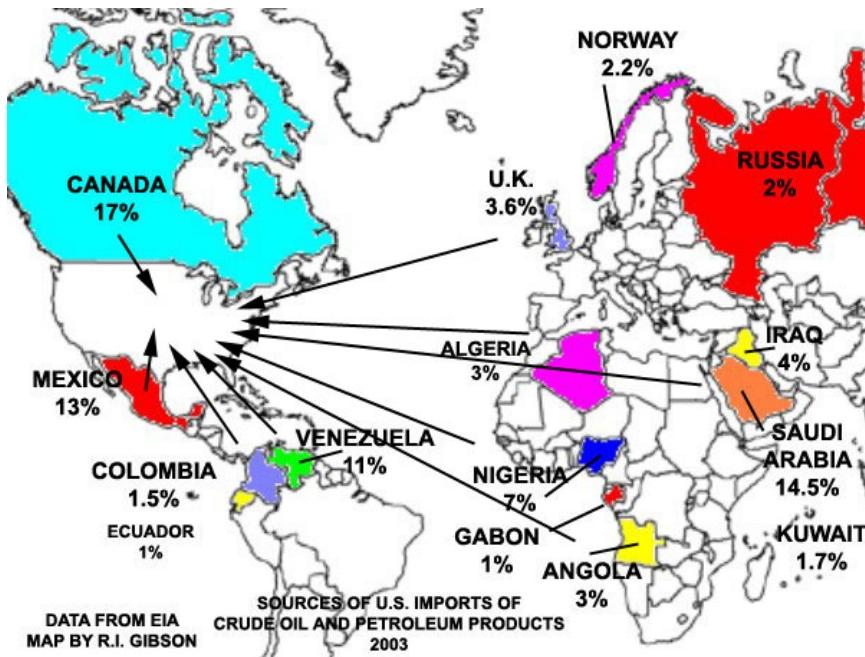


Figure 8: 2003 U.S. Crude Oil Imports by Source²⁶

Canada

Canada has been the largest supplier of U.S. imported oil since 1996. Although Canadian oil reserves total only 4.5 billion barrels, Canada is estimated to have approximately 180 billion barrels of oil trapped in tar sands. Tar sands are extracted by strip mining and steam injection to separate the thick bitumen from the sand. The tar sand mining procedure causes extensive ecological devastation and requires vast quantities of water. At one site in northern Alberta, wastewater from the separation process is held in a catchment pond four miles across and twenty feet deep.²⁷ Tar sand oil production produces two tons of waste sand for every barrel of oil produced. Two barrels of oil energy are required for every three barrels produced.²⁸ The long-term prognosis of tar sand oil depends on energy input by cheap natural gas, another limited commodity.²⁹ Further growth in this resource requires overcoming problems of complexity, cleanliness and cost.³⁰ Regardless of the future of tar sands, Canada's excess production, political stability and proximity make it a critical asset in U.S. energy security.

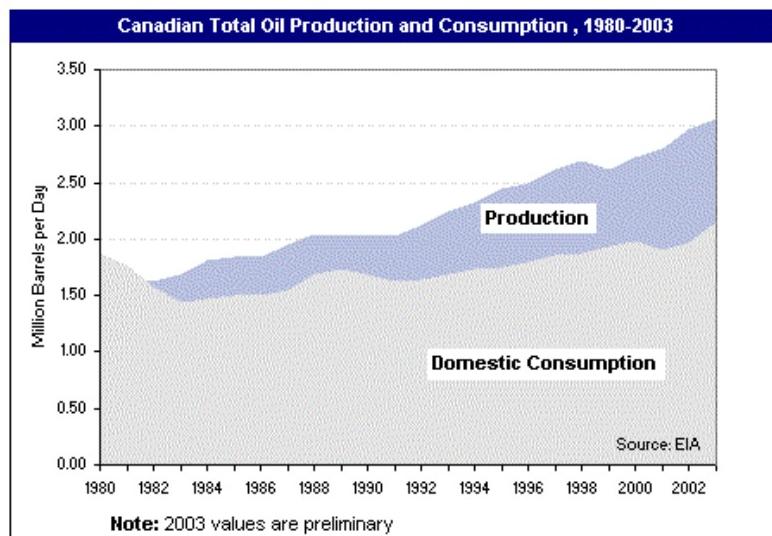


Figure 9: Canadian Oil Production Since 1980³¹

Saudi Arabia

Saudi Arabia has the world's largest proven oil reserve, currently estimated at approximately 250 billion barrels (Gb) of oil.³² Peak Saudi production will not happen until 2020, thus Saudi Arabia is and will remain "the indispensable nation of oil".³³ Saudi Arabia is ruled as a feudal monarchy, with absolute power held by the descendants of Abd al-Aziz ibn Saud who rose to power in 1932. Since the death of ibn Saud in 1953, internal in-fighting among his descendants has placed four successive princes on the Saudi throne, held today by King Fahd whose incapacitation in 1995 devolved the conduct of government to Crown Prince Abdallah. Since his elevation to Prime Minister, Abdallah has waged a campaign within the royal family to curb the excesses of members of the extended family. Abdallah's ethics campaign has earned him many enemies among the 5,000 males who claim title as a "prince" in the Saudi royal family and delayed his rise to outright rule in Saudi Arabia.³⁴ The vast oil wealth of Saudi Arabia masks a nation with pressing demographic and political problems. More than half of all Saudis are younger than eighteen years of age. This group is plagued by limited educational opportunities and high unemployment, factors which have made

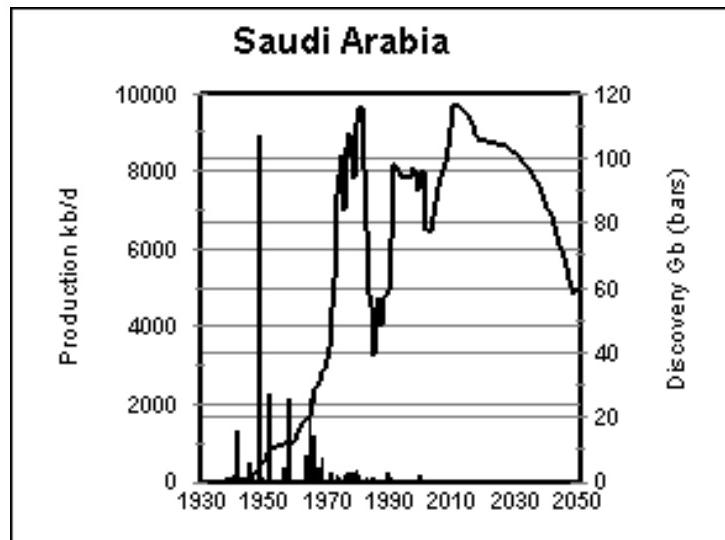


Figure 10: Saudi Arabian Oil Production: Historic and Forecast³⁵

Saudi Arabia fertile ground for religious extremism.³⁶ The official state religion is Wahhabism, an inimical form of Islam that is the philosophical antecedent for Osama Bin Laden and his followers--fifteen of the nineteen 9/11 hijackers were Saudi citizens. Critics of the Saudi royal family claim that during the 1990s, they provided extensive financial assistance to Al Qaeda, due both to religious conviction and fear that fundamentalist groundswell could topple the regime. In July 2002 Laurent Murawiec, an influential analyst with the Rand Corporation told the Defense Advisory Board: “The Saudis are active at every level of the terror chain, from planners to financiers, from cadre to foot soldier, from ideologist to cheerleader. Saudi Arabia supports our enemies and attacks our allies [and is responsible for a] daily outpouring of virulent hatred against the U.S. from Saudi media, ‘educational’ institutions, clerics, [and] officials. Saudis tell us one thing in private, [and] do the contrary in reality.”³⁷ Saudi Arabia faces rising internal opposition. The Saudi government claims to have taken steps to eliminate terrorist funding and curtail Al Qaeda recruitment within the kingdom, however, the long-term prognosis for success is unknown.³⁸ In the meantime, Saudi Arabia remains “the indispensable nation of oil,” *the* key linchpin of U.S. energy security, yet a crucial supplier beset by political tension, internal dissent, and a looming demographic crisis.

Mexico

Mexico is tied to the U.S. economy through the North American Free Trade Agreement (NAFTA), which has been a mixed blessing for Mexicans. Although elimination of all trade barriers led to a flood of foreign investment and industrialization during the 1990s, many of these jobs have since moved on to even lower wage countries in Central America and Asia. NAFTA was championed as a solution for emigration problems, however, Mexicans continue to

migrate north in search of employment and wages to send back to Mexico in the form of remittances.³⁹ This outflow of workers, coupled with the corrosive effects of a burgeoning narcoeconomy represent the greatest future social challenges to Mexico.

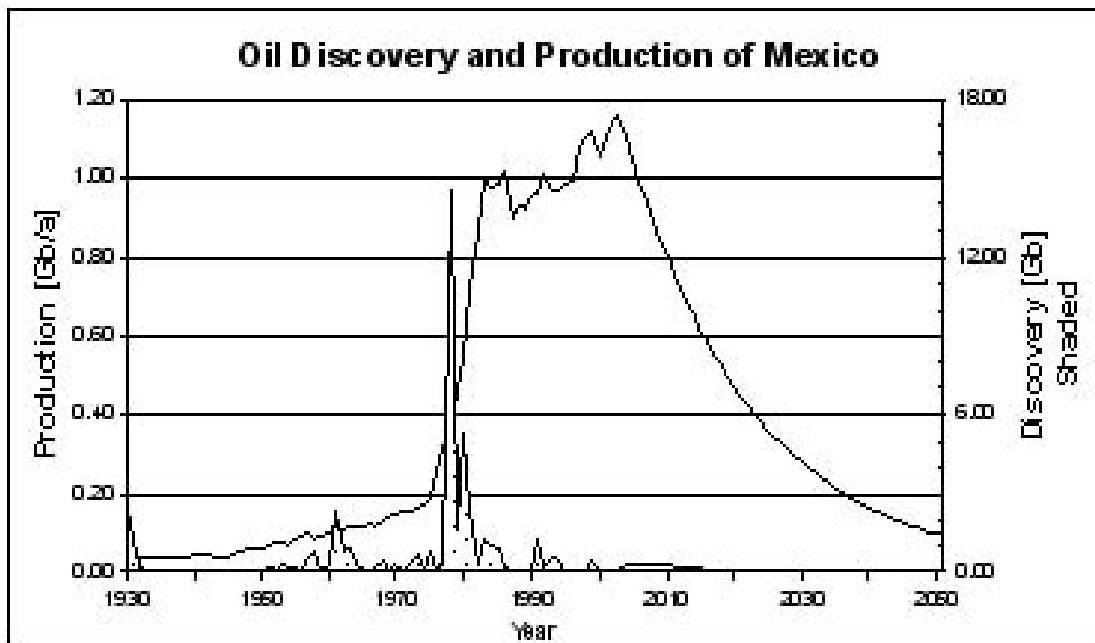


Figure 11: Oil Discovery and Production of Mexico⁴⁰

Mexico has made no major oil discovery since 1980. The pessimists estimate that Mexico has approximately 22 Gb of oil remaining. Mexican production will peak around 2015. Although Mexico is a net oil exporter, growing domestic consumption will exceed production by 2010, closing the Mexican spigot as a source of oil for the U.S.⁴¹

Venezuela

The Venezuelan oil industry was born in 1866; only seven years after production began in the United States. Venezuela's unique geology led to the rapid rise in her importance as a world oil supplier. Venezuela used this leadership in 1960 to midwife the birth of OPEC, going on to nationalize Venezuelan resources in 1976.⁴² "Venezuelan political history has been one of

revolution, counter-revolution and dictatorship".⁴³ The latest chapter in Venezuela's history began with the election of Hugo Chávez in 1998. Although Chávez came to power as a populist reformer, an 18% contraction in the economy and his dictatorial practices triggered a national work stoppage in 2002, slowing oil production to a trickle.⁴⁴ Chávez' rigid support for Venezuela's oligarchic social structure, massive capital flight and a 60% poverty rate bode ill for the future of democracy.

The pessimists estimate that Venezuela possesses about 50 Gb of remaining conventional oil reserves. Exploitation of these conventional reserves peaked in approximately 2003. Venezuela also has a vast reserve of heavier oils, estimated as high as 1,200 Gb, a quantity that equals the entire conventional reserve remaining world-wide. The greatest barrier to exploiting this resource has been the low recovery rate of useable oil (about 10-15%) and the high front-end cost of investment required to exploit these heavy oils. In the early 1990s, the Venezuelan government set the exploitation tax at 1% in an effort to draw the massive foreign investment required to bring heavy oils on-line. In October 2004, President Chávez' raised these tax rates to 16% in an effort to correct what he called "foreign domination mechanisms."⁴⁵ Heavy oil production results have so far been modest due to substantial energy consumption associated with the production process.⁴⁶

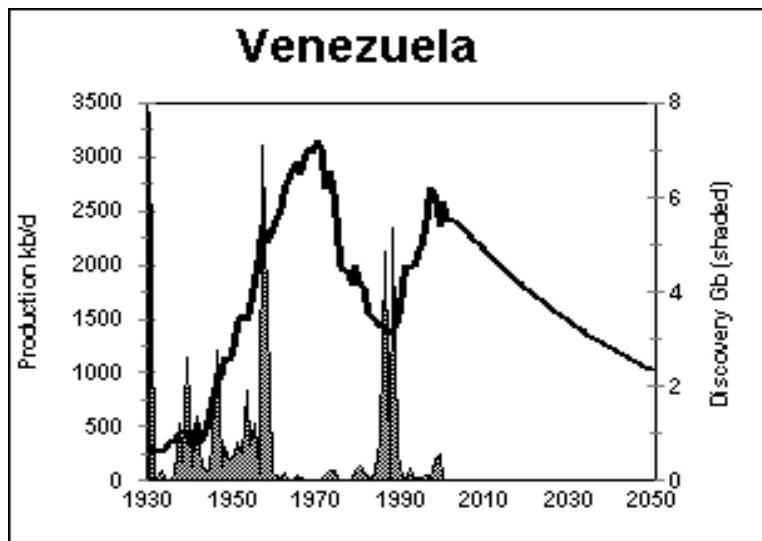


Figure 12: Oil Discovery and Production of Venezuela⁴⁷

Low internal consumption and crucial non-conventional oil resources will place Venezuela at the forefront of importance a U.S. energy source for decades. Assured access to these resources will be dependent on the policies of Hugo Chávez and his successors.

Nigeria

Nigeria was a British colony from 1906 until 1960 when it gained its independence. Between 1966 and 1999, Nigeria was ruled by a series of military governments, and torn by ethnic civil war and religious strife. Nearly two million Nigerians are believed to have perished from violence, hunger and disease.⁴⁸ Following a succession of governments, Nigeria today is ruled by a democratically elected government, which retains a well-deserved reputation for corruption.

“Consider the situation in Nigeria. For decades, powerful elites in the capital of Abuja have monopolized the allocation of petroleum revenues, providing relatively little to the ethnic minorities of the Niger Delta region, where most of the oil is buried. These groups -- including the Ijaw and the Ogoni -- have grown increasingly dissatisfied with the prevailing system and so have launched armed attacks on local oil facilities to make their point. The result, of course, is a sharp drop in exports.”⁴⁹

Nigeria still retains substantial oil resources, estimated by the pessimists to total approximately 40 Gb, with a production peak forecast in approximately 2009.⁵⁰

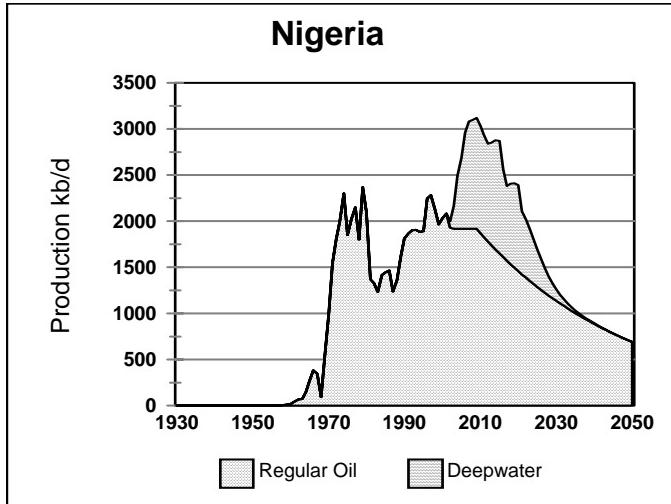


Figure 13: Oil Discovery and Production of Nigeria⁵¹

The continued viability of the U.S. energy lifeline hinges on political and economic stability in nations such as Saudi Arabia, Venezuela, and Nigeria. Little excess oil production capacity exists in the world. Interruption of oil production in any of the unstable countries described in this chapter would trigger immediate price rises and economic dislocation. The simultaneous loss of several oil producing nations due to boycott, sabotage or war would be a world economic catastrophe.

Chapter 5

The Military Challenge

The True Cost of U.S. Energy Policy

Ongoing military operations in the Middle East and Central Asia undertaken to ensure energy access and price stability have placed an invisible “subsidy” on the true cost of imported oil. From 1991-2004, the average cost of a gallon of unleaded gas at a U.S. gas pump ranged as high as \$2.07.⁵² When the United States’ \$2.2 trillion cost of 9/11 and all Middle East/Central Asia operations since Desert Shield are factored into the 1.71 trillion gallons of gas that American consumers have used since 1991,⁵³ our “subsidized” cost at the pump rises to \$3.35 per gallon⁵⁴ (see Appendix 1). The current U.S. energy strategy understates these large (and growing) monetary and human costs of seeking energy security through military action. The “invisible hand” of market forces, which should trigger oil conservation at a price of \$3.35 per gallon, has been disrupted by the externalized cost of American diplomatic and military efforts.

Securing the U.S. Oil Supply in a Region of Instability

Future military efforts to secure the U.S. oil supply pose tremendous challenges due to the wide number of potential crisis areas. Besides the nations already mentioned, the vast remainder of the world’s oil reserve is concentrated in the Middle East and Central Asia. In order of proven resources, these countries are Iraq, Kuwait, U.A.E., Iran, Russia, and the nations

surrounding the Caspian Basin. This region, especially the Arab nations, has been referred to as the “gap”⁵⁵, an area characterized by poverty, disorder, and great social upheaval.

One area of concern is the Arab world. A 2002 report, jointly published by the U.N. and the Arab Fund for Economic and Social Development cited

“the three main reasons the Arab world is falling off the globe. The G.D.P. of Spain is greater than that of all 22 Arab states combined. In brief, it's due to a shortage of freedom to speak, innovate and affect political life, a shortage of women's rights and a shortage of quality education. A serious freedom deficit undermines human development. The whole Arab world translates about 300 books annually--one-fifth the number that Greece alone translates...In spite of progress in school enrollment, 65 million Arab adults are still illiterate, almost two-thirds of them women.”⁵⁶

The Middle East is faced with explosive population growth. By 2020 this area’s population is projected to reach over 800 million souls, a 30% increase from today. This surge will place huge strains on already struggling Middle Eastern governments, in the process providing a ready source of recruits for grievance organizations such as Al Qaeda, for whom dissatisfied young males have been described as a “center of gravity”⁵⁷

The story of U.S. diplomacy in the Middle East is a mélange of two irreconcilable objectives, the need to ensure access to Middle East oil poised against a policy of steadfast support for Israel and the Zionist movement. Since the birth of the Israeli state in 1948, successive administrations have sought to achieve both goals, a task that will be increasingly difficult to realize as the rise of militant Islamism and the Israeli-Palestinian situation conspire to accelerate Middle East instability. America’s feckless policy in the Middle East has repeatedly found us aligning with the “wrong” regime—as evidenced by our continued support for the Saudis, and our episodic support for the Shah of Iran, and even Saddam Hussein. If alliance is defined as shared goals and values, today we have no “true” allies in the Middle East, only allies

in the model of the U.S./Soviet alliance of World War II, where we allied with an avowed enemy because “my enemy’s enemy is my friend.”

The Caspian Basin

The last oil frontier lies around the Caspian Sea. Although previous estimates placed total oil resources as high 110 Gb, further exploration has lowered expectations to a range of 17-33 Gb, well below Iraq or Kuwait, but still a substantial quantity of oil.⁵⁸ Over the long-term, it is believed that natural gas may prove to be the most valuable resource in the Caspian Basin.⁵⁹ Exploiting these resources presents a host of unique problems.

“Russia, Kazakhstan, Turkmenistan, Iran, and Azerbaijan have not come to an agreement on the territorial division of the Caspian Sea. Division of the Caspian was formerly described in a bilateral treaty between Soviet Union and Iran, with the dissolution of the Soviet Union, status of the bilateral is thrown into question. How the Caspian Sea (and its oil) will be distributed is hotly disputed--Iranians have already resorted to gunboat diplomacy to prevent exploration in contested parts of the Caspian.”⁶⁰

Assuming these resource ownership problems can be resolved, the next problem is delivering the oil and natural gas to markets. Four of the six Caspian Sea nations are former Soviet republics, and as such, are eager to free themselves of all vestiges of Russian domination. Only two of these four nations, Azerbaijan and Kazakhstan have significant oil resources. In the cases of Turkmenistan and Uzbekistan their only hope of enjoying economic benefits comes through pipeline transit fees. As shown in Figure 17, all existing and proposed pipeline routes pass through some of the world’s most war-torn real estate, including one proposed pipeline across Afghanistan.

The bulk of demand during the next decade will come from Asia. “In 1993, after decades of self-sufficiency, Chinese domestic oil production could no longer satisfy demand, which had shot up because of the country's extraordinary economic growth. Since then, China has had to

import more oil every year, from 6.4 percent of its total consumption in 1993, to 31 percent in 2002, to a projected 60 percent by 2020.” Taken as a whole, the Asia-Pacific region’s dependence on Middle Eastern oil may exceed 90% by 2010.⁶¹

U.S. military and economic efforts to expand oil access in the Caspian Basin, à la our actions over the past sixty years in the Persian Gulf, could bring the U.S. into direct conflict with energy-hungry regional powers like China and India. Such conflict, played out far from our traditional supply lines, would minimize U.S. advantages in air and naval power, depending largely on ground forces and asymmetric warfare.



Figure 14: Existing and Proposed Caspian Basin Pipeline Routes⁶²

The Incredibly Vulnerable Oil Delivery Infrastructure

The world energy delivery system is incredibly fragile. This vulnerability creates a vast universe of options for nations, terrorists, and anti-globalists to create mischief by sabotage, destruction of key facilities, or interdicting transportation bottlenecks. “Saudi Arabia has just

two primary oil export terminals: Ras Tanura - the world's largest offshore oil loading facility, through which a tenth of global oil supply flows daily.”⁶³ An attack on the world’s largest oil production facility, Saudi Arabia’s Abqaiq processing facility, could take 50% of Saudi oil off the market for at least six months, triggering a worldwide economic catastrophe. “Such an attack would be more economically damaging than a dirty nuclear bomb set off in midtown Manhattan or across from the White House in Lafayette Square.”⁶⁴

Chapter 6

World Oil Consumption

U.S. Energy Consumption Patterns

There are clear warning signs that global oil production is approaching Hubbert's Peak.

In order to understand the implications of declining oil production, it is necessary to review the role that oil plays in meeting the overall energy needs of the U.S. Figure 14 combines 25 years of U.S. energy consumption history with a prediction forward to 2025.

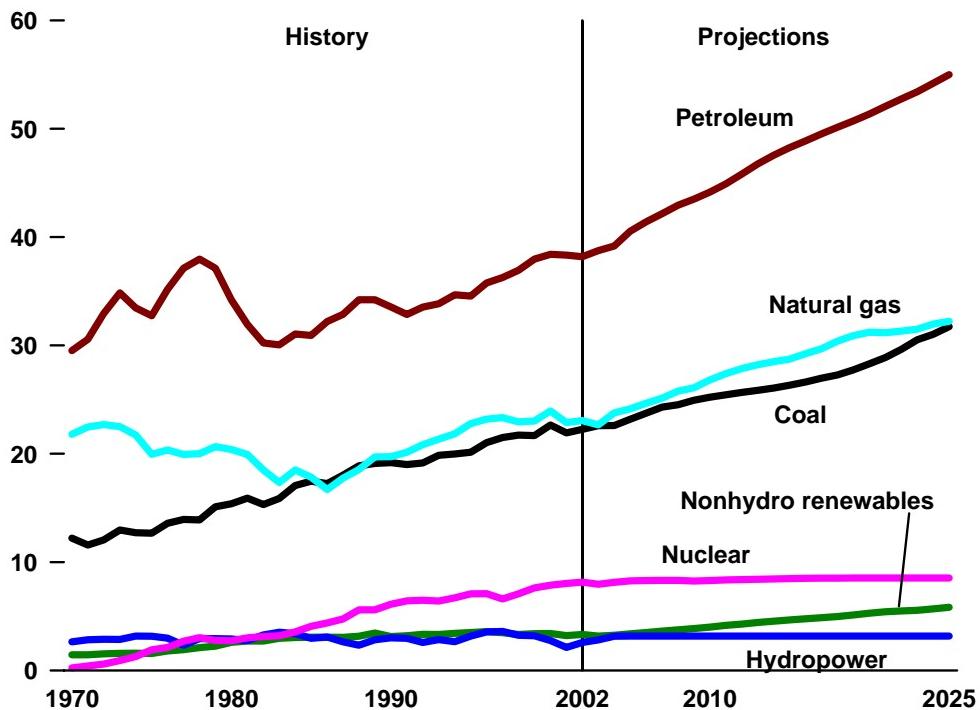


Figure 15: U.S. Energy Consumption by Fuel, 1970-2025 (quadrillion Btu)⁶⁵

Oil and gas currently provide 65% of all commercial energy used worldwide.⁶⁶

Petroleum provides nearly 40% of all energy used in the U.S., a share that is forecast to rise over the next 20 years.⁶⁷ Increasing U.S. reliance on oil as a source of energy coupled with declining domestic production will trigger ever-increasing demand for foreign oil. Figure 15 plots current and forecast oil consumption and levels of importation. Today, imports comprise a 62% share of total petroleum consumption. By 2025, this share is predicted to rise to 70%.

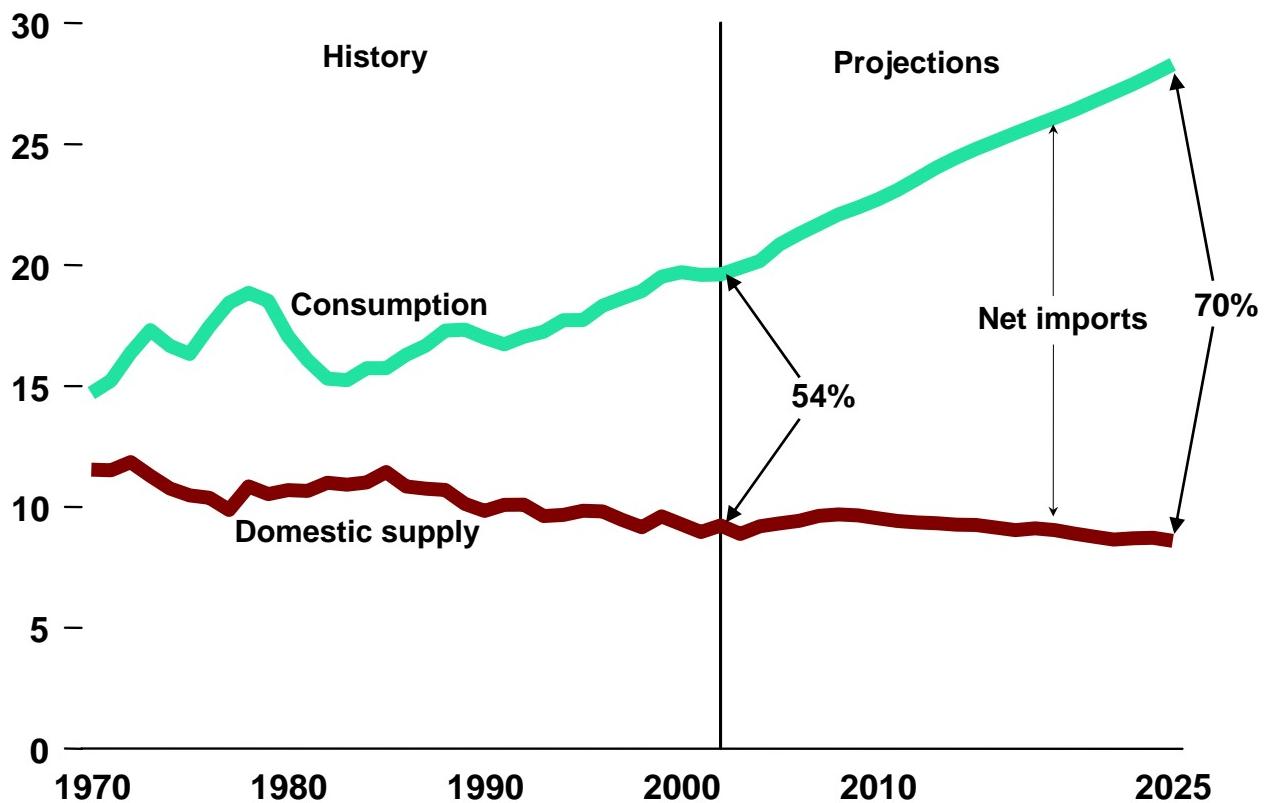


Figure 16: U.S. Petroleum Supply, Consumption, and Imports, 1970-2025

(Millions of barrels per day)⁶⁸

The main users of petroleum are the transportation and industrial sectors of the U.S. economy. Oil provides 95% of the energy for transportation and 20% of the energy for the industrial sector.⁶⁹ The impending peak in world production coupled with heavy reliance on

imported oil will present great challenges for the economy as a whole, but especially the transportation sector.

Politics at the Peak

Recognition that world oil supplies have reached Hubbert's Peak will have major political and economic implications within the industrial world. World-wide oil consumption is rising at a rate of 3% annually, with the greatest growth coming in China.⁷⁰ A major obstacle to fielding a viable replacement to the petroeconomy is the huge infrastructure cost and lack of short-term economic incentives. The worldwide oil energy industry generates revenues in excess of \$2.1 trillion dollars annually.⁷¹ Transition to alternative fuels and technologies is ultimately a decision rendering part or all of this huge investment worthless, and will not be undertaken until the economic arguments are unimpeachable. "Most transportation technologies have long useful lifetimes--15 years or more."⁷² Although rising oil prices and sagging supplies will eventually produce clear incentives to conserve and deploy alternative energy sources, in many cases these conversion incentives may not arrive until very late in the supply collapse, minimizing the time for classic economic incentives to act.

The first barrier to solving this problem lies in public and policymaker perceptions. Oil price shocks and fluctuations have been commonplace since 1974, each time the warnings proved false. For this reason alone, it may prove very difficult to convince the public and policy makers that a new era of permanently limited oil supplies has arrived. Predicting the "shape" of the post-peak oil supply is also very difficult. Although Hubbert's theoretical work depicted a symmetrical curve of growing and then shrinking production, the actual production pattern is highly dependant on the geology of individual oil fields and the level of investment in production technology. Further, some portion of the production shortfall may be offset by

conservation and increased use of other fuels such as natural gas, oil sands, coal gasification, and synthetic oil. During World War II, German engineers discovered that “synthetic oils manufactured from coal become viable substitutes at around \$60 per barrel.”⁷³ As shown in Figure 16, the shape of the peak and the impact of “swing” fuels such as synthetic oil are difficult to predict. However, the key fact to remember is that none of these replacement technologies will happen overnight; rather they will be the result of deliberate policy and investment decisions with lead-times that may approach a decade.

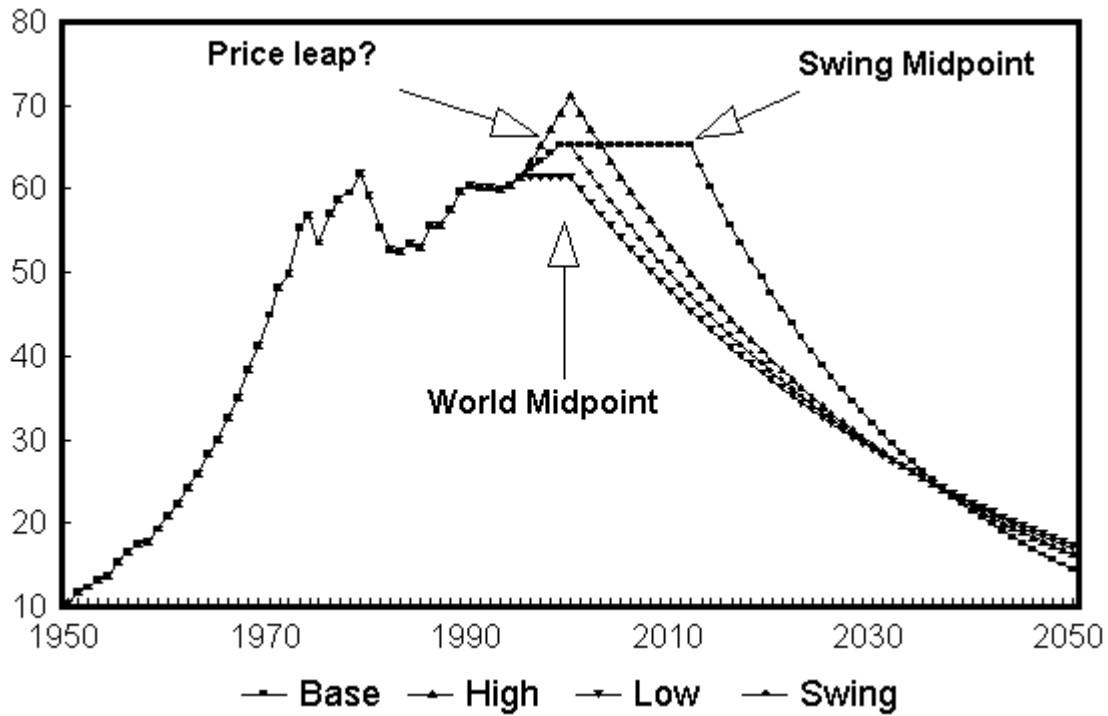


Figure 17: Postulated Future Trends in Oil Production and Pricing⁷⁴

Three possible oil depletion scenarios are outlined below in Table 2. “Awash in Oil and Gas” is a business-as-usual scenario in which the fears of the oil supply pessimists prove to be unfounded. “Technology Triumphs” is an evolutionary process of scientific breakthroughs and timely public policy decisions that convert this potential crisis into a soft landing. “Turbulent

World” is the revolutionary sequence of events that could result from a failure to recognize the coming crisis and act decisively.⁷⁵

Scenario	Energy Supply	Energy Consumption	Government Action	Environmental Issues	Transport Technology	Economy
“Awash in Oil and Gas”	Cheap oil and gas available	Consumers use as much energy as they want	Minimum federal intervention in energy markets	Annual carbon emissions grow over 50%	Conventional cars and trucks, no efficiency improvements	Increased economic activity
“Technology Triumphs”	Alternative energy supplies penetrate market (e.g. hydrogen, bio-fuels,	Primary energy use grows by less than 25% by 2020	Pubic funded research into new technologies, Government regulations increase engineering and environmental performance	Econ-wide carbon emissions increase by 15%	Fuel cell and hybrid vehicles capture a substantial and growing share of transportation car market	Rapid and sustained economic growth
“Turbulent World”	High prices for fuel and electricity	The combination of high demand and erratic energy supplies yields steady energy consumption increases	Policy makers cannot control external events; no coherent energy technology policy	Carbon emissions rise to 15% above 2000 level by 2010	“Moonshot” program to produce one million fuel cell cars by 2025	Unstable economy and slow growth

Table 2: Three U.S. Energy Scenarios for the 21st Century: A Comparison⁷⁶

Chapter 7

A Manhattan Project for Energy Independence Needed Now

U.S. energy policy is trapped on the horns of dilemma. Current policy over-estimates the remaining available oil supply. A large fraction of the oil that does remain lies beneath unstable and distant countries. Current U.S. efforts to ensure energy access and security in these oil nations have imposed a hidden subsidy on the cost of energy. This hidden subsidy restrains Adam Smith's "invisible hand" of market forces. Were the true cost of oil access recognized, the search for alternatives would proceed far more quickly.

"We need to adopt a "bridging" strategy based on the increased use of natural gas, enhanced conservation and fuel efficiency, greater reliance on wind and solar power, and the gradual introduction of hydrogen-powered devices. But...time is running out. Each year that we fail to commit to serious energy research and development or fail to begin slowing the growth of energy demand through fuel efficiency...is another year in which our already unstable energy economy moves so much closer to the point of no return."⁷⁷

Avoid or Mitigate This Train Wreck Through Yankee Ingenuity

America faces a strategic imperative to decisively deploy a range of solutions, both interim and permanent to address energy security. Before discussing what will work, let's discuss for a moment what will not work. "Solving" this problem by expanding oil exploration or developing additional resources off-shore or in the Arctic will not provide the long-term solution. Oil economics over the past decade have supplied great incentive to discover more sources of oil. Despite these incentives and ever more sophisticated technology, new discoveries are not keeping pace with consumption. Alaskan production at Prudhoe Bay peaked in 1988.⁷⁸

The much-touted Alaskan ANWR is estimated to contain about 7.7 billion barrels of recoverable oil, enough to supply the U.S. for just over one year.⁷⁹ Although tar sands and heavy oil hold promise, their economics and energy balance are daunting at best. Trying to drill our way out of this crisis will not address the real problem, which is soaring demand and the danger of military conflict over shrinking oil resources.

Phase I: Fuel Conservation

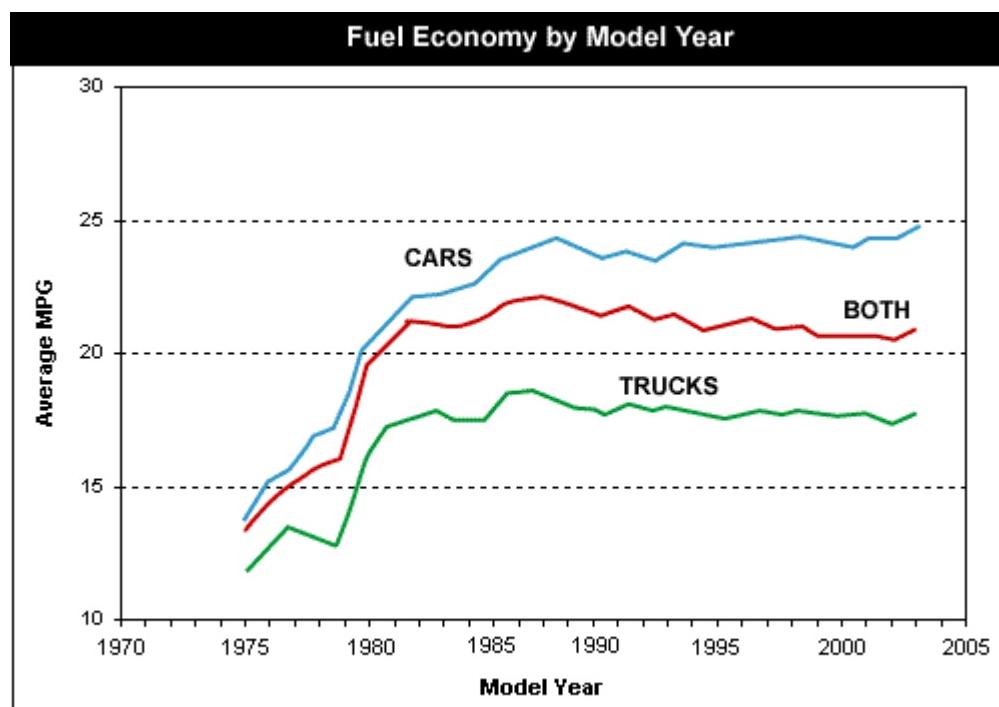
Since 1974, oil conservation through mandated fuel economy has been a policy of every Presidential administration. According to the 2005 EPA fuel economy guide, the Honda Insight, a \$20,000 hybrid vehicle shown in Figure 18 gets 61 MPG in the city and 66 MPG on the highway. Using the EPA's standard of 15,000 miles per year and a fuel cost of \$1.80 per gallon for regular unleaded gasoline, the cost difference between the Honda Insight and a less economical vehicle such as the Acura NSX is \$1,029 per year.



Figure 18: Honda Insight

The overall U.S. fuel savings record is not impressive. The aftermath of the 1973-1974 oil embargo saw the establishment of government mandated automotive mileage standards. By 1985, the average fuel economy of the U.S. fleet had risen from 12.9 MPG to approximately 27

MPG.⁸⁰ However, since 1985, these gains have remained largely static as economy targets remained unchanged. These standards have been thwarted by the policy decision to set separate lower economy standards for trucks. “In 2003, truck sales in the U.S. hit an all-time high of 8,865,894 pickups, vans, and SUVs. That worked out to 53.2 percent of all new-vehicle sales, another all-time high. In the first month of 2004, the trucks' share of the market grew even more, to 54.6 percent.”⁸¹ Since peaking in 1987, the growing percentage of lower-economy trucks has led to a decline in overall economy of the U.S. automotive fleet.



Source: U.S. EPA, *Light-Duty Automotive Technology and Fuel Economy Trends: 1975 Through 2003*

Figure 19: U.S. Automotive Fuel Consumption Trends

Even at \$2.00 per gallon, there are few incentives for Americans to conserve gas. At this price level, the annual cost penalty of driving a gas-guzzling SUV instead of a more economical four door car is about \$500 per year.⁸² The dearth of economic incentives coupled with gas

prices considerably lower than the highly taxed Europeans means that consumption of oil per dollar of GDP is now more than 40 percent higher in the U.S. than in Germany and France.⁸³

The citizens of the U.S. have learned this consumptive behavior through the absence of negative stimuli and consequences. In the aftermath of the 1973-1974 oil embargo, which featured gas lines, price spikes, and widespread shortages, U.S. consumers dutifully replaced their gas guzzling Detroit iron with more economic Japanese models. During the ensuing years, oil prices declined, and as memories faded, both Congress and the public lost their sense of urgency. Today, the prevalence of SUVs suggests that consumers are basing their decisions on non-economic factors such as power, comfort, utility, and the belief that a large vehicle is safer in an accident. Although buying an SUV imposes an added fuel cost of up to \$5,000 over a ten year period, for many Americans, this cost is either not considered, or apparently deemed tolerable.

The first goal of the Manhattan Project is to reinvigorate fuel economy mechanisms through government action. The American public is not inherently greedy, just poorly informed. Government policy that champions the need for fuel economy is crucial. Replacing every vehicle on the road with a high mileage hybrid would cut consumption in half, eliminating the need for imported oil. Improving the average fuel efficiency of the entire U.S. car fleet by just 5.3 miles per gallon could displace all Persian Gulf imports.⁸⁴

Hybrid Automobiles

Hybrids are a revolution in automotive design that combine both a conventional gas engine and an electric motor. When stopped, or at very slow speeds, the hybrid moves solely by the electric motor. At typical driving speeds, hybrids are powered by the gas engine. During

maximum acceleration, both the gas and electric motors are used. Perhaps the greatest difference between a hybrid and a regular automobile is that during deceleration, energy to slow the vehicle is recovered electrically by “regenerative braking” and stored in the car’s battery for use later. Regenerative braking is a key energy saving advantage for hybrids over current auto designs that waste braking energy as heat. There are three hybrid cars and three hybrid trucks among the 2005 model year offerings. The three cars, all from Japanese automakers, average over 50 MPG and are mature designs of considerable research and engineering. During 2003, the first year of offering, 47,000 hybrids were sold. Sales in 2004 are expected to exceed 100,000 vehicles, rising to 440,000 by 2008. Although 440,000 seems an impressive number, it represents only 2.75% of the annual market of 16 million vehicles sold in the U.S. each year.⁸⁵

The companion of the hybrid is the flexible fuel vehicle (FFV). FFV vehicles are designed to operate on mixed fuels up to E85, 15% gasoline and 85% ethanol. Today, there are more than 4 million FFVs on the road.⁸⁶ FFV is a proven technology that adds a fuel sensor in the engine to adjust for different fuels. Retrofit to FFV capability costs about \$50 per vehicle.⁸⁷ Increased reliance on ethanol fuel can offset imported oil with a domestic product, thus improving energy security and the U.S. trade balance. Due to lower energy content, E85 users see a 5-12% reduction in fuel efficiency over conventional fuels.⁸⁸ On the positive side, E85 fuels reduce exhaust emissions by over 50%.

Ethanol augmented fuels are available mainly in the Midwest, where ethanol is made using a corn-based fermentation process. Corn ethanol enjoys a variety of state and federal tax exemptions that result in lower pump prices than conventional petroleum fuels. Today, 81 plants around the country are manufacturing corn ethanol with a capacity of 3.4 billion gallons per year. Fifteen additional plants under construction will add a further 670 million gallons per year

of capacity.⁸⁹ It is estimated that limits on arable land and competition from other corn users will limit corn ethanol production to a maximum of approximately 8 billion gallons per year.⁹⁰ Corn ethanol production of 8 billion gallons per year could replace 7 billion gallons of imported gasoline per year, generating a 5.3% offset of the 130 billion gallon annual domestic gasoline consumption.⁹¹

Corn ethanol critics point out that it takes more energy (in the form of fertilizers, farm machinery, processing into ethanol, etc) to grow the corn and distill the ethanol than is available in the final product. The corn ethanol production chain is dominated by corporate producers who have mobilized substantial political support for a corn ethanol tax subsidy regime that totals \$1.4B per year.⁹² Corn ethanol is problematic since corn is the most irrigation and fertilizer intensive crop grown in the U.S. Additionally, corn used for ethanol drives cattle feed prices higher, creating additional hidden costs at the grocery store.

Corn ethanol production should be replaced as quickly as practical with ethanol based on waste biomass. Corn is a valuable food commodity. Corn ethanol costs about \$2.24 per gallon to produce, making it an uneconomical fuel source except in times of very high oil prices.⁹³

The Biorefinery

The biorefinery produces ethanol using the starches and cellulose present in agricultural waste and by-products such as corn stalks, rice straw, paper mill waste, recycled urban waste, or dedicated woody stemmed crops.⁹⁴ Many of these potential sources of “cellulosic” ethanol are considered “negative cost” feed stocks, meaning that they have no food value and farmers must pay for their disposal. The negative cost of these feed stocks gives cellulosic ethanol a much

higher net energy balance than corn-based ethanol, since the monetary value of the feed stock is zero. Studies accomplished at candidate biorefinery sites in Indiana and Nebraska found that co-locating ethanol biorefineries with existing power plants would allow cellulosic ethanol to be produced at a cost ranging from \$1.05/gal to \$1.60/gal depending on the biomass selected. Both sites studied had ample quantities of corn stover (stalks and corncobs) available to support a large plant.⁹⁵ Cellulosic ethanol production offers great promise for rural areas of the U.S. that have seen considerable depopulation due to modern farming methods. “One cellulose ethanol plant would enhance energy security by replacing crude oil imports of 2.4 to 2.9 million barrels per year; increase farm income by \$25 million per year by creating economic value for residues that currently...have little to no value or are simply viewed as waste; create economic development by creating over 1,000 new jobs during peak construction, and almost 200 new permanent jobs and about 450 spin-off jobs.”⁹⁶ Biorefineries also hold great promise for urban areas. Studies have shown that a typical large city has a substantial surplus of yard waste and wood debris, products that can no longer be deposited in landfills. New York and Philadelphia pay \$150 per ton to dispose of municipal solid waste.⁹⁷ Delivering these wastes to an urban ethanol plant addresses both landfill and energy problems. Creating a simple urban wood recycling routine of household recycling bins, similar to those already practiced throughout Europe would ensure a steady biomass supply and strengthen the economics of urban biorefineries through proximity to markets. Building an urban biorefinery in each of the hundred largest U.S. metropolitan areas could produce 7 billion gallons of ethanol per year, offsetting 5% of our imported oil while helping solve existing urban waste problems.

The biorefinery is not a fanciful dream. In 1975, Brazil initiated a domestic ethanol program based on sugarcane waste. Over its 29 year life, the Brazilian ethanol industry has

produced \$50B of ethanol while supporting 700,000 domestic Brazilian jobs.⁹⁸ Electricity co-generated at Brazilian biorefineries provides 9% of national requirements.⁹⁹ Brazilian ethanol supports one fourth of domestic petroleum demand and can be profitably priced more cheaply than gasoline.¹⁰⁰ According to a study by the Rocky Mountain Institute, a \$180B U.S. investment in biorefineries undertaken over the next decade could yield a \$130B in *annual* savings by 2025.¹⁰¹ According to testimony in the U.S. Senate, sufficient cellulosic biomass is available in the U.S. *right now* to construct up to 200 cellulosic ethanol plants displacing as much as 10% of the oil that we import today.¹⁰²

On October 28, 2004, a Chevrolet Yukon powered by E85 cellulosic ethanol completed a 16,000 km trip across Canada. This project was undertaken to publicize that Iogen, a Canadian corporation, is operating the world's first full-scale cellulosic ethanol plant and will increase cellulosic ethanol production capacity to 100 million gallons by 2006.¹⁰³

Implementing Phase I

The conservation measures described here hold great promise as a means to realize meaningful reductions in U.S. oil needs. Unfortunately, if Hubbert's Peak arrives in 2007, the opportunity to implement this program in advance of crisis may be already past, and instead this program may be implemented in response. Many aspects of the program will be costly and bitterly opposed by partisan interest groups. It will be the task of national leadership to frame the argument and stay the course. This job may be made easier by incontrovertible proof of oil shortage.

(1). The first step in the implementation process will be to emplace economic incentives to conserve fuel. New hybrid vehicles enjoy a tax credit of \$1,500 which is due to expire in 2006.¹⁰⁴ This tax credit program must be expanded, and although taxation and incentives are anathema to many politicians, a cost-neutral regime that taxes production and purchase of “low economy” models and rebates purchase of Hybrids and E85s must be imposed.

(2). The second step is to resume increasing the corporate average fuel economy (CAFE) fleet fuel economy requirements. The CAFE requirement has remained static at 27.5 MPG since 1985, while light trucks and SUVs have essentially received a free ticket. The CAFE fuel economy requirement must resume its move upward in a fashion that produces sound public policy outcomes without exceeding the engineering capability of the automotive industry. The SUV and light truck requirement, set at 20.7 MPG, needs a realistic economy target that balances the needs of the consumer as well as national energy security.

(3). The third step in fuel economy implementation will require the federal government to institute a crash program to build cellulosic ethanol facilities. Placement studies for ethanol plants designed to consume a mixture of agricultural wastes and grain have estimated a construction cost of \$27M to build a facility capable of producing up to 15 million gallons of ethanol per year. In the case of a proposed site in North Dakota, suitable agricultural waste and inconsumable grain is already available to produce 12.5 million gallons per year of ethanol at zero cost.¹⁰⁵ Some potential sites could even solve *existing* waste disposal problems, exploiting “negative cost” biomass to turn waste into

treasure.¹⁰⁶ National Renewable Energy Lab (NREL) studies show that an investment of \$31B would build 225 ethanol plants capable of producing enough ethanol to replace over 10% of the existing gasoline consumption (see appendix 2). Reducing or eliminating state and federal taxes on E85 fuel will ensure the profitability of this nascent industry, even as reduced U.S. oil consumption may lead to a short-term drop in the price of gasoline. The NREL estimates that a new ethanol plant can be built within fourteen months, with production within eighteen months, rapidly bringing this cellulosic ethanol production capability on-line. Although it is not feasible to simultaneously build 225 ethanol plants, construction at the most promising sites must begin immediately.

(4). Farmers need incentives to grow energy crops such as switchgrass, a native plant that does not require fertilizer or irrigation. It is estimated that “roughly 15% of the North American continent consists of land that is unsuitable for food farming but workable for switchgrass cultivation. If all that land was planted with switchgrass, we could replace every single gallon of gas consumed in the U.S. with ethanol.”¹⁰⁷ Farm policies that encourage establishment of energy crop plantations are crucial to the creation of a firm supply base for cellulosic ethanol.

Biorefineries provide an interim energy source that enhances U.S. energy security while smoothing the transition to the next phase of the Manhattan Project, the hydrogen economy. A key feature in the design of the biorefinery will be the capability for spiral modernization to hydrogen production within approximately 25 years, as the initial ethanol plant investment approaches obsolescence and maturity of the hydrogen economy defines the mechanism for production, be it wind power, biomass, or some other means.

Phase II: The Hydrogen Economy

Although the “hydrogen economy” is widely cited in political discourse, the true nature and practicality of hydrogen has yet to be settled. Proponents of the hydrogen economy cite the vast renewable energy resources available on the earth from sources such as the wind, solar and biomass. Massive wind farms, occupying merely a portion of the Dakotas are theoretically capable of producing sufficient hydrogen through electrolysis to power all transportation needs in the U.S. Wind generator technology is improving very rapidly. U.S. consumers pay a seasonal range of 4-8¢ per kWh for electricity, depending on location. Operational wind farms in Minnesota and Oregon are now producing electricity at an average cost of 2.5¢ kWh.¹⁰⁸ Wind power has great promise for certain regions of the U.S., but will require a massive capital investment.

Japanese automakers have made huge inroads towards developing practical hydrogen powered vehicles. The 2005 Honda FCX is a hydrogen fueled vehicle powered by a sophisticated fuel cell. The FCX produces 107 horsepower, an overall fuel economy of 57 MPG, and has a cruising range of 190 miles. Best of all, the FCX is a zero emission vehicle.¹⁰⁹



Figure 20: Honda FCX

Practical implementation of the hydrogen economy is still several decades into the future. Defining and meeting the technological challenges of the hydrogen economy stands at the core of the Manhattan Project. Although the steps outlined in phase I will offer some breathing space against the demise of the oil-based economy, rising demand and falling production suggest that a transition to hydrogen must be defined, capitalized, and executed with rigor. The Bush administration has budgeted \$2B for hydrogen research. Given that the U.S. has spent \$2.2T over the past fourteen years seeking energy security through military action, \$50B spent to accelerate the arrival of the Hydrogen economy would seem a public policy decision whose brilliance would rank with President Jefferson's Louisiana Purchase or Secretary of State Seward's purchase of Alaska. Whatever the final form of the hydrogen economy, be it directly fueling vehicles with hydrogen or perhaps with some other hydrogen-rich fuel such as ethanol, an all-out technical effort to make hydrogen a reality is a strategic imperative.

A Huge Ancillary Bonus: Clean Air

Environmentalists have championed many of these ideas for years, largely ignored, or grudgingly placated with half-measures. Up until now, economic considerations have trumped many of the environmentalist's arguments as cheap gas and lack of government commitment knocked the props out from under the green platform. The Manhattan Project provides an ideal convergence of interests, bringing the economist, the diplomat, the environmentalist and the politician all under the same tent. In addition to girding U.S. energy security, hybrids and E85 vehicles offer drastic improvements in the pollution characteristics of the transportation sector. Hybrids and ethanol fuels emit far less pollution. Wider use of a bio-fuel generates a net

reduction in greenhouse gases since the carbon dioxide emitted at the tailpipe will be reconverted to energy through the biomass growth cycle.

Chapter 8

Conclusion

America's Strategic Imperative

The current world energy situation poses a threat to the U.S. unparalleled in 225 years of history. The U.S. economy, particularly the transportation component, has become incredibly dependent on oil from foreign sources. Concurrent with this rising demand are indications that world oil production may soon peak, followed by permanent decline and shortage. Even if the reader remains unconvinced that world oil production is approaching a peak, it cannot be denied that most of the remaining oil in the world is concentrated in distant, politically hostile locations, a situation that invites interdiction by our enemies.

Why is the world oil market and its effects on the U.S. economy a military topic? To arrive at an answer, we must refer to the four pillars of U.S. National Security Strategy: Diplomatic, Informational, Military and Economic. Over the last sixty years, U.S. policy makers have repeatedly applied diplomatic and military triage to the problem of our nation's energy security, while generally ignoring the economic aspects of a solution. Today, the U.S. is engaged in a Global War on Terror throughout the same resource-rich area upon which the safety of our economy hinges. Economic stagnation or catastrophe lurks close at hand, triggered by another oil embargo, collapse of the Saudi monarchy, or civil disorder in any of a dozen other

nations where such disorder is only weakly restrained. Barring these events, rising world demand, coupled with an impending plateau or fall in production could place the U.S. in direct military competition with other nations equally determined to seize the world's last barrel of oil. It is highly doubtful that any military, even that of a global hegemon could secure an oil lifeline indefinitely. Failing to take urgently required economic steps *now* will necessitate far more painful economic steps *later* and likely require protracted military action.

Solving this economic and technical problem with a technical solution plays on America's greatest strengths, those of the inventor and the innovator. Rapid execution of a two-phase Manhattan Project will provide near-term relief measures while laying the foundation for the long-term establishment of the hydrogen economy. Reduced dependence on imported oil would also allow the U.S. to pursue a more pragmatic foreign policy freed of the necessity to engage in all episodes of Middle East or OPEC history. Additionally, this strategy offers the opportunity to deny Al Qaeda and their allies a key argument in their war against the U.S.--reducing the strategic importance of the Middle East will obviate the need for "us" to be "there", thus reducing the cultural friction between Muslims and the West. Absent the plausible charge that U.S. efforts in the Middle East are motivated solely by oil, U.S. efforts to nurture democracy, and local perception of our efforts could result in a new era of good will.

On top of tremendous strategic benefits, deploying an effective regime of energy efficiency offers the ancillary benefit of building national policy consensus across a wide range of domestic interest groups by addressing other vexing problems such as global warming and air pollution. Although this problem is daunting, it is not unsolvable, but instead demands prompt sure action to ensure an energy-rich and peaceful future.

"When you are drifting down the stream of Niagara, it may easily happen that from time to time you run into a reach of quite smooth water, or that a bend in the river or a change

in the wind may make the roar of the falls seem far more distant. But your hazard and your preoccupation are in no way affected thereby.”

--Winston Churchill¹¹⁰

Appendix 1

Costs of Middle East Operations and 9/11, 1991-2004

Total Cost of Gulf War I ¹¹¹	\$300B
Annual Peacetime Force Structure Cost for Units Tasked for the Middle East (\$60B x 13 Years) ¹¹²	\$780B
Annual Cost of No-Fly Zone Enforcement and Deployed Army Forces in Kuwait 1991-2002 (\$15.3B x 11 Years) ¹¹³	\$168.3B
Economic Costs to the U.S. Economy of the 9-11 Attacks ¹¹⁴	\$585.2B
Cost of Operations in Iraq (Based on Substantial Withdrawal in 2008) ¹¹⁵	\$308.9B
Cost of Operation Enduring Freedom and Follow-on Operations in Afghanistan (\$1.6B / mo in 2002 + \$1.1B / mo 2003-2004) ¹¹⁶	\$45.6B
Uzbekistan Aid and Airfield Access Payments 2002 ¹¹⁷	\$.320B
Uzbekistan Aid and Airfield Access Payments 2003-4 ¹¹⁸	\$.357B
Foreign Aid to Pakistan, 2002 ¹¹⁹	\$.696B
Foreign Aid for Pakistan 2003-2004 ¹²⁰	\$1.2B
Foreign Aid and Airfield Access for Kyrgyzstan ¹²¹	\$.500B
Foreign Aid for Tajikistan ¹²²	\$.563B
Foreign Aid to Turkmenistan ¹²³	\$.274B
Total Costs	\$2191.91B
Total U.S. Gasoline Consumption 1991-2004 (gallons) ¹²⁴	1716.96B
Hidden Fuel Price Subsidy at the Pump (Cost of Middle East Operations / Total Consumption)	\$1.276 / Gal

Appendix 2

Economic Costs of Large-Scale Bio Refineries

Hard Capital Cost of (1) 70 Million Gallon Per Year (MMGPY) Ethanol Biorefinery ¹²⁵	\$135.6M
Cost of Building 225 Biorefineries, Assuming 100% Capitalization by Federal Government (Worst Case) (225 x \$135.6M)	\$30.56B
Total Ethanol Production of 225 Biorefineries (225 x 70 MMGPY)	15750 MMGPY
Oil Offset Assuming 12% Energy Loss—Ethanol vs Oil (Total Ethanol Production x .875)	13781 MMGPY
Offset Oil Imports Assuming Consumption Remains 130 Billion Gallons per Year (Total Ethanol Produced/130 Billion)	10.6%

Bibliography

1. President, Report, “National Energy Policy: Report of the National Energy Policy Development Group,” 16 May 2001, 9.
2. Ibid, 154.
3. Ibid, 154.
- 4 Ibid, 9.
5. Ibid, 66.
6. Ibid, 65.
7. Department of Energy, *FY2004 Congressional Budget Request*, (Washington, D.C.: Office of Management, Budget and Evaluation), 16.
8. *Arctic National Wildlife Refuge, 1002 Area, Petroleum Assessment, 1998, Including Economic Analysis*, US Geological Survey (Washington, D.C. Department of the Interior, 1998), Internet, 12 November 2004, available from <http://pubs.usgs.gov/fs/fs-0028-01/fs-0028-01.htm>.
9. President, Report, “National Energy Policy: Report of the National Energy Policy Development Group,” 16 May 2001, 130.
10. *International Petroleum Consumption (Demand) Annual Data*, United States Department of Energy, Energy Information Agency, (Washington, D.C.: Department of Energy, December 2004), Internet, 7 December 2004, available from <http://www.eia.doe.gov/emeu/international/petroleu.html#ConsumptionA>.
11. “The Hubbert Curve,” Geo 3005 Earth Resources, Internet, 15 November 2004, available from <http://www.geo.umn.edu/courses/3005/resource.html#hubbert>.
12. Vincent Ramirez, “Oil Crises Delay -- A World Oil Price Forecast,” Petroleum Services, (Switzerland, 1999), Internet, 11 November 2004, available from http://members.aol.com/vrex/oil/price_forecast.htm.
13. Colin J. Campbell, “Oil Discovery and Production Plots by Country,” Association for the Study of Peak Oil, (Cork, Ireland, 2002), Internet, 11 November 2004, available from <http://www.asponews.org/plots.php?plot=USA%20Lower%2048>.

-
14. Kjell Aleklett, "Oil and Gas - a Short Period of History for Great Britain," Association for the Study of Peak Oil, (Uppsala, Sweden, 2004), Internet, 11 November 2004, available from <http://www.peakoil.net/OilGasUK.html>.
15. "High Oil Price and Depletion," Association for the Study of Peak Oil, Newsletter 45—September 2004, (Cork, Ireland, 2004), Internet, 11 November 2004, available from <http://www.peakoil.net/Newsletter/NL45/newsletter45.doc>.
16. "A Strategy: Moving America Away From Oil," The Arlington Institute (Arlington, Va.: Arlington Institute, August 2003), 27.
17. "High Oil Price and Depletion," Association for the Study of Peak Oil, Newsletter 45—September 2004, (Cork, Ireland, 2004), Internet, 11 November 2004, available from <http://www.peakoil.net/Newsletter/NL45/newsletter45.doc>.
18. "The General Depletion Picture," Association for the Study of Peak Oil, Newsletter 50—February 2005, (Cork, Ireland, 2005), Internet, 9 February 2005, available from <http://www.peakoil.net/Newsletter/NL50/newsletter50.doc>.
19. Ibid.
20. Ibid.
21. BP-AMOCO, BP Statistical Review of World Energy: June 2004, Internet, 11 November 2004, available from <http://www.bp.com/sectiongenericarticle.do?categoryId=2012412&contentId=2018341>.
22. Guy Caruso, *US Oil Markets and the Middle East*, United States Department of Energy, Energy Information Agency, 20 October, 2004, Internet, 11 November 2004, available from <http://www.eia.doe.gov/neic/speeches/Caruso102004.ppt#269,17>, World Oil Reserves by Country, as of January 1, 2004.
23. "The General Depletion Picture," Association for the Study of Peak Oil, Newsletter 46—October 2004, (Cork, Ireland, 2004), Internet, 11 November 2004, available from <http://www.peakoil.net/Newsletter/NL46/newsletter46.doc>.
24. BP-AMOCO, BP Statistical Review of World Energy: June 2004, Internet, 11 November 2004, available from <http://www.bp.com/sectiongenericarticle.do?categoryId=2012412&contentId=2018341>.
25. *Crude Oil and Total Petroleum Imports Top 15 Countries*, United States Department of Energy, Energy Information Agency, (Washington, D.C.: Department of Energy, October 2004), Internet, 11 November 2004, available from

http://www.eia.doe.gov/pub/oil_gas/petroleum/data_publications/company_level_imports/current/import.html.

26. Dick Gibson, "Some Interesting Oil Industry Statistics," Gibson Consulting, (Butte, Montana, 2004), Internet, 12 November 2004, available from <http://www.gravmag.com/oil.html>.
27. Richard Heinberg, *The Party's Over: Oil, War and the Fate of Industrial Societies* (Gabriela Island, B.C., Canada, 2003) 112.
28. Ibid, 112.
29. Gal Luft, "Can Canadian Sands Replace Arabias?", *Energy Pulse*, 31 Jul 2003, Internet, 12 November 2004, available from
http://www.energypulse.net/centers/article/article_display.cfm?a_id=421.
30. "Could Canada's tar sands prove the ultimate anti-OPEC resource?", Alexander's Gas and Oil Connections, 8 August 2003, 12 November 2004, available from
<http://www.gasandoil.com/goc/news/ntn33230.htm>.
31. *Country Analysis Briefs: Canada*, United States Department of Energy, Energy Information Agency, (Washington, D.C.: Department of Energy, January 2004), Internet, 12 November 2004, available from <http://www.eia.doe.gov/emeu/cabs/canada.html>.
32. "Country Assessment: Saudi Arabia," Association for the Study of Peak Oil, Newsletter 21—September 2002, (Cork, Ireland, 2002), Internet, 12 November 2004, available from
<http://www.asponews.org/ASPO.newsletter.021.php#99>.
33. "Saudi Arabia and Oil: What If?", *The Economist*, 27 May 2004, Internet, 12 November 2004, available from http://www.economist.com/business/displayStory.cfm?story_id=2705562.
34. Seymour M. Hersh, "King's Ransom: How Vulnerable Are The Saudi Royals?", *The New Yorker*, 22 October 2001, Internet, 12 November 2004, available from
http://www.newyorker.com/PRINTABLE/?fact/011022fa_FACT1.
35. "Country Assessment: Saudi Arabia," Association for the Study of Peak Oil, Newsletter 21—September 2002, (Cork, Ireland, 2002), Internet, 12 November 2004, available from
<http://www.asponews.org/ASPO.newsletter.021.php#99>.
36. Ibid.
37. Erich Marquard, "Saudi Arabia: The US-Saudi Schism," *Diplomatic Traffic*, Internet, 12 November 2004, available from http://www.diplomatictraffic.com/debate_archives.asp?ID=225.

-
38. Jim Hoagland, "Preying on Saudi Arabia," *Washington Post*, 3 June 2004, Internet, 12 November 2004, available from <http://www.washingtonpost.com/wp-dyn/articles/A11254-2004Jun2.html>.
39. House, *U.S. Immigration Policy: Hearings before the Judiciary Subcommittee on Immigration, Claims, and Adjustments*, 107th Cong., 2d sess., 2003, Internet, 12 November 2004, available from <http://www.house.gov/judiciary/griswold103003.pdf>.
40. "Country Assessment: Mexico," Association for the Study of Peak Oil, Newsletter 35—November 2003, (Cork, Ireland, 2003), Internet, 12 November 2004, available from <http://www.asponews.org/HTML/Newsletter35.html>.
41. Ibid.
42. "Country Assessment: Venezuela," Association for the Study of Peak Oil, Newsletter 22—October 2002, (Cork, Ireland, 2002), Internet, 12 November 2004, available from <http://www.asponews.org/ASPO.newsletter.022.php#106>.
43. Ibid.
44. *Country Analysis Briefs: Venezuela*, United States Department of Energy, Energy Information Agency, (Washington, D.C.: Department of Energy, June 2004), Internet, 12 November 2004, available from <http://www.eia.doe.gov/emeu/cabs/venez.html>.
45. Iain Bruce, "Venezuela Raises Oil Drilling Tax," *BBC News World Edition*, 11 October 2004, Internet, 12 November 2004, available from <http://news.bbc.co.uk/2/hi/americas/3732224.stm>.
46. Pierre-René Bauquis, "What Future For Extra Heavy Oil And Bitumen : The Orinoco Case," World Energy Council, (London, United Kingdom, 2004), Internet, 12 November 2004, available from http://www.worldenergy.org/wecgeis/publications/default/tech_papers/17th_congress/3_1_04.asp.
47. "Country Assessment: Venezuela," Association for the Study of Peak Oil, Newsletter 22—October 2002, (Cork, Ireland, 2002), Internet, 12 November 2004, available from <http://www.asponews.org/ASPO.newsletter.022.php#106>.
48. *Wikipedia*, 2004 ed., s.v. "Nigerian Civil War." Internet, 12 November 2004, available from http://en.wikipedia.org/wiki/Nigerian_Civil_War.
49. Michael T. Klare, "Growing Militarization of our Oil Dependence," *The Boston Globe*, 12 October 2004, Internet, 12 November 2004, available from

http://www.boston.com/news/globe/editorial_opinion/oped/articles/2004/10/12/growing_militarization_of_our_oil_dependence/.

50. "Country Assessment: Nigeria," Association for the Study of Peak Oil, Newsletter 27—March 2003, (Cork, Ireland, 2003), Internet, 12 November 2004, available from <http://www.asponews.org/docs/Newsletter27.doc>.

51. Ibid.

52. US Department of Energy, Energy Information Agency, "Retail Gasoline Historical Prices," 2004, on-line, Internet, 11 November 2004, available from http://www.eia.doe.gov/oil_gas/petroleum/data_publications/wrgp/mogas_history.html.

53. US Department of Energy, Energy Information Agency, "Retail Gasoline Historical Prices," 2004, on-line, Internet, 11 November 2004, available from http://www.eia.doe.gov/oil_gas/petroleum/info_glance/gasoline.html.

54. Nicholas Varchaver, "How to Kick the Oil Habit," *Fortune*, 23 August 2004, on-line, Internet, 11 November 2004, available from <http://www.fortune.com/fortune/brainstorm/0%2C15704%2C678503%2C00.html>.

55 Thomas P. M. Barnett, *The Pentagon's New Map: War and Peace in the Twenty-first Century* (New York, N.Y.: G.P. Putnam's Sons, 2004), 4.

56. Thomas L. Friedman, "Arabs at the Crossroads," *The New York Times*, 5 July 2002, Internet, 12 November 2004, available from <http://www.frontpagemag.com/Articles/ReadArticle.asp?ID=1696>.

57. General Anthony Zinni, USMC (ret), "Peace in the Middle East," lecture, Air War College, Maxwell AFB, Al., 20 September 2004.

58. Lutz Kleveman, *The New Great Game—Blood and Oil in Central Asia* (New York, N.Y.: Atlantic Monthly Press, 2003), 3.

59. *Country Analysis Briefs: Caspian Sea Region*, United States Department of Energy, Energy Information Agency, (Washington, D.C.: Department of Energy, June 2004), Internet, 12 November 2004, available from <http://www.eia.doe.gov/emeu/cabs/caspian.html>.

60. Kleveman, 146-147.

61. *Energy Security in East Asia*, Institute for the Analysis of Global Security, 13 August 2004, Internet, 12 November 2004, available from <http://www.iags.org/n0813042.htm>.

62. *Country Analysis Briefs: Caspian Sea Region*, United States Department of Energy, Energy Information Agency, (Washington, D.C.: Department of Energy, June 2004), Internet, 12 November 2004, available from <http://www.eia.doe.gov/emeu/cabs/caspian.html>.

63. Gal Luft and Anne Korin, "Terror's Next Target," *The Journal of International Security Affairs*, December 2003, Internet, 12 November 2004, available from <http://www.iags.org/n0111041.htm>.

64. Ibid.

65. *Annual Energy Outlook 2004: With Projections to 2025*, United States Department of Energy, Energy Information Agency, (Washington, D.C.: Department of Energy, January 2004), 5.

66. Andrew McKillop, "Energy transition and final energy crisis," *VHeadline.com*, 10 October 2004, Internet, 11 November 2004, available from <http://www.vheadline.com/readnews.asp?id=23067>.

67. *Annual Energy Outlook 2004: With Projections to 2025*, United States Department of Energy, Energy Information Agency, (Washington, D.C.: Department of Energy, January 2004), Internet, 11 November 2004, available from http://www.eia.doe.gov/oiaf/aoe/figure_47.html.

68. *Annual Energy Outlook 2004: With Projections to 2025*, United States Department of Energy, Energy Information Agency, (Washington, D.C.: Department of Energy, January 2004), Internet, 11 November 2004, available from <http://www.eia.doe.gov/oiaf/aoe/gas.html#opcon>.

69. *Oil Market Basics*, United States Department of Energy, Energy Information Agency, (Washington, D.C.: Department of Energy, January 2004), Internet, 11 November 2004, available from http://www.eia.doe.gov/pub/oil_gas/petroleum/analysis_publications/oil_market_basics/Demand_text.htm#U.S.%20Consumption%20by%20sector.

70. Ronald Soligo and Amy Jaffe, *China and Long-range Asia Energy Security: An Analysis of the Political, Economic and Technological Factors Shaping Asian Energy Markets*, Center for International Political Economy, 31 March 2003, Internet, 11 November 2004, available from http://www.vitrade.com/china/china_lr_security_asian_energy.htm#Forecasts%20for%20Future.

71. Energy Intelligence, *The Energy Intelligence Top 100: Ranking the World's Oil Companies*, (New York, N.Y.: 2004), Internet, 7 December 2004, available from <http://www.energyintel.com/about.asp?id=g>

72. David G. Victor and Nadejda M. Victor, "Axis of Oil?," *Foreign Affairs*, March/April 2003, n.p.

-
73. Vincent Ramirez, "Oil Crises Delay -- A World Oil Price Forecast," Petroleum Services, (Switzerland, 1999), Internet, 11 November 2004, available from http://members.aol.com/vrex/oil/price_forecast.htm.
74. Colin J. Campbell, *The Twenty First Century The World's Endowment of Conventional Oil and its Depletion*, Association for the Study of Peak Oil, (Cork, Ireland, 1996), Internet, 12 November 2004, available from <http://www.oilcrisis.com/campbell/camfull.htm>.
75. Ibid.
76. "A Strategy: Moving America Away From Oil," The Arlington Institute (Arlington, Va.: Arlington Institute, August 2003), 34.
77. "Crude Awakening," *The Nation*, 21 October 2004, Internet, 12 November 2004, available from <http://www.thenation.com/doc.mhtml?i=20041108&c=5&s=clare>.
78. *Energy in the United States: 1635-2000*, United States Department of Energy, Energy Information Agency, Internet, 11 November 2004, available from <http://www.eia.doe.gov/emeu/aer/eh/frame.html>.
79. *Arctic National Wildlife Refuge, 1002 Area, Petroleum Assessment, 1998, Including Economic Analysis*, US Geological Survey (Washington, D.C. Department of the Interior, 1998), Internet, 12 November 2004, available from <http://pubs.usgs.gov/fs/fs-0028-01/fs-0028-01.htm>.
80. CAFE Standards, Internet, 12 November 2004, available from <http://www.davidbarber.org/research/cafe.html>.
81. Csaba Csere, "Saving Gas Through Semantic Definitions," *Car and Driver*, May 2004, Internet, 12 November 2004, available from http://www.caranddriver.com/article.asp?section_id=27&article_id=8022&page_number=1.
82. *SUV and Pickup Gas Guzzling the "Driving Force" Behind Large U.S. Appetite for Gas, Summer 2003 High Gas Prices*, The Public Citizen, (Washington, D.C.: 2004) Internet, 12 November 2004, available from http://www.citizen.org/documents/gas_prices.pdf.
83. Martin Feldstein, *Oil Dependence and National Security: A Market-based System for Reducing U.S. Vulnerability*, National Bureau of Economic Research (Cambridge, Ma.: October 2001) Internet, 12 November 2004, available from <http://www.nber.org/feldstein/oil.html>.
84. *Fuel Supplies and Security*, Rocky Mountain Institute (Snowmass, Co.: 2004) Internet, 12 November 2004, available from <http://www.rmi.org/sitepages/pid405.php>.

-
85. Tom Holden, “Sales of Hybrid Cars Take Off,” *The Virginian-Pilot*, 11 June 2004, Internet, 12 November 2004, available from <http://home.hamptonroads.com/stories/story.cfm?story=71544&ran=221494>.
86. *Stinker Stations Opens Idaho’s First E85 Fueling Station E85 Provides Fuel Alternative to Idaho Residents*, National Ethanol Vehicle Coalition (Jefferson City, Mo.: 2004) Internet, 12 November 2004, available from http://www.e85fuel.com/news/110504_boise_id_go.htm.
87. Sam Jaffe, “Independence Way,” *The Washington Monthly*, July/August 2004, 20.
88. *Handbook for Handling, Storing and Dispensing E85*, US Environmental Protection Agency (Washington D.C. Department of Energy, 2002), Internet, 12 November 2004, available from <http://www.e85fuel.com/pdf/5902guidebook.pdf>.
89. *Bushmills Ethanol, Inc. Begins Construction On Plant*, Renewable Fuels Association, (Washington D.C.: 2004) Internet, 12 November 2004, available from <http://www.ethanolrfa.org/pr041110.html>.
90. Oregon Department of Energy, *Ethanol Forum: A Closer Look at Ethanol Issues*, (Salem, Or.: May 2001) Internet, 13 November 2004, available from <http://www.energy.state.or.us/biomass/forum.htm#Energy>.
91. Annual U.S. Fuel Consumption, Internet, 13 November 2004, available from <http://www.epa.gov/icr/icr2000/1591.13/1591ss13.htm>.
92. Roger Segelken, “CU agricultural ecologist continues criticism of corn-based ethanol,” Cornell Chronicle, 14 August 2003, Internet, 13 November 2004, available from <http://www.news.cornell.edu/Chronicle/03/8.14.03/Pimentel-ethanol.html>.
93. David Pimentel, “Ethanol Fuels: Energy Balance, Economics, and Environmental Impacts are Negative,” Natural Resources Research, Vol. 12, No. 2, June 2003, Internet, 16 November 2004, available from http://www.acfa.ws/Support%5CPimentel_Nat%27l%20Resour%20Res_Jun%202003.pdf.
94. BC International Corporation, *Ethanol From Biomass Process*, (Dedham, Ma.) Internet, 13 November 2004, available from <http://www.bcintlcorp.com/technology.htm>.
95. Michael D. Mann, “Feasibility Of Producing Ethanol From Biomass In Northeastern North Dakota And Northwestern Minnesota,” Energy and Environmental Research Center, Internet, 16 November 2004, available from <http://www.westbioenergy.org/reports/mm-ethanol.htm>.

96. Senate, *Proceedings and Debates of the 108th Congress—Second Session*, Vol 150, No. 110, 15 September 2004, Internet, 14 November 2004, available from
<http://www.iogen.ca/news/040921%20Craig%20floor%20statement%20on%20CR%20letterhead.pdf>.

97. Lester B. Lave, W. Michael Griffin, and Heather MacLean, “The Ethanol Answer to Carbon Emissions,” *Issues in Science and Technology*, Winter 2001-2002, 75.

98 Amory B. Lovins, et al, *Winning the Oil Endgame*, (Aspen, CO.: Rocky Mountain Institute, 2005) n.p.

99 Ibid.

100 Ibid.

101 Abstract: Winning the Oil Endgame, Internet, 9 February 2005, available from
<http://www.oilendgame.org/Abstract.html>

102. Senate, *Proceedings and Debates of the 108th Congress—Second Session*, Vol 150, No. 110, 15 September 2004, Internet, 14 November 2004, available from
<http://www.iogen.ca/news/040921%20Craig%20floor%20statement%20on%20CR%20letterhead.pdf>.

103. Sam Jaffe, “Independence Way,” *The Washington Monthly*, July/August 2004, 18.

104. Holden.

105. BBI International, *Grand Forks, North Dakota Ethanol Feedstock Resource Assessment Final Report*, (Cotopaxi, Co.: 18 May 2001), Internet, 14 November 2004, available from
<http://www.westbioenergy.org/reports/nderept.htm>.

106. Lee R. Lynd, *Overview and Evaluation of Fuel Ethanol From Cellulosic Biomass: Technology, Economics, the Environment, and Policy*, Annual Review of Energy and the Environment, (Palo Alto, Ca.: 1996) 445.

107. Jaffe, 18.

108. Heinberg, 140.

109. H2CARSBIZ, *2005 Honda FCX U.S. Certified for Commercial Use*, (Ikast, Denmark: 30 June 2004), Internet, 15 November 2004, available from
http://www.h2cars.biz/artman/publish/article_593.shtml.

-
110. William Manchester, *The Last Lion: Winston Spencer Churchill Alone 1932-1940* (New York, Little, Brown and Co., 1988), 198.
111. Grant T. Hammond, *Myths of the Gulf War*, Aerospace Power Journal (Maxwell AFB, Al.: AU Press, 1998), Internet, 16 November 2004, available from <http://www.airpower.maxwell.af.mil/airchronicles/apj/apj98/fal98/hammond.html>.
112. Amory B. Lovins, *Science News*, Fall 2003, Internet, 16 November 2004, available from <http://www.north-rthn.org/Newsletters/ABSN-Fall-03.pdf>.
113. House Budget Committee, Democratic Caucus, *The Cost of War and Reconstruction in Iraq: An Update*, 108th Cong., 1st sess., 2003, Internet, 16 November 2004, available from http://www.house.gov/budget_democrats/analyses/iraq_cost_update.pdf.
114. Robert Looney, “Economic Costs to the United States Stemming From the 9/11 Attacks,” *Strategic Insight*, (Monterey, Ca.: Naval Postgraduate School, August 2002).
115. Ibid.
116. Dennis Ryan, “Comptroller Tallies Operation Iraqi Freedom Cost,” *Pentagram*, 18 April 2003, Internet, 16 November 2004, available from http://www.dcmilitary.com/army/pentagram/8_15/national_news/22760-1.html.
117. Lutz Kleveman, *The New Great Game—Blood and Oil in Central Asia* (New York, N.Y.: Atlantic Monthly Press, 2003), 173.
118. Department of State, *Background Note: Uzbekistan*, Internet, 16 November 2004, available from <http://www.state.gov/r/pa/ei/bgn/2924.htm>.
119. Lutz Kleveman, *The New Great Game—Blood and Oil in Central Asia* (New York, N.Y.: Atlantic Monthly Press, 2003), 245.
120. Department of State, *Background Note: Pakistan*, Internet, 16 November 2004, available from <http://www.state.gov/r/pa/ei/bgn/3453.htm>.
121. Lutz Kleveman, *The New Great Game—Blood and Oil in Central Asia* (New York, N.Y.: Atlantic Monthly Press, 2003), 186.
122. Department of State, *U.S. Assistance to Tajikistan Fact Sheet*, Internet, 16 November 2004, available from <http://www.state.gov/r/pa/prs/ps/2002/15766.htm>.
123. Department of State, *U.S. Assistance to Turkmenistan Fact Sheet*, Internet, 16 November 2004, available from <http://www.state.gov/p/eur/rls/fs/29492.htm>.

124. Department of Transportation, *Corporate Average Fuel Economy Standards*, Internet, 16 November 2004, available http://www.nhtsa.dot.gov/cars/rules/rulings/CAFE/EnvAssessd/Index.html#_Toc26683550.

125. BBI International, *Feasibility Study for Bioethanol Co-Location with a Coal Fired Power Plant*, (Cotopaxi, Co.: 28 July 2002), Internet, 16 November 2004, available from <http://www.nrel.gov/docs/fy03osti/32999.pdf>.